

# The Path-way to perfect SAYLING.

Shewing briefly the six principall Points  
or Grounds of

## NAVIGATION.

Written by Mr. RICHARD POLTAR, one of the late principall Masters of the Navie Royall,

And now published for the Common good of all Masters, Pilots, and other Sea-men whatsoever.

---

Whereunto is added,

**A NAUTICALL DISCOURSE**  
necessary to be knowne of all SEA-MEN, to prove  
the way of a Ship (upon the Superficies of the Sea) outward and homeward to be both one, returning by the opposite Point of the Meridian Compass:

And also to prove the East and West directed by the Meridian Compass to lead in a Magneticall paralell.

First penned by JOHN BASSET deceased, a Teacher of Navigation at Chatham in Kent.

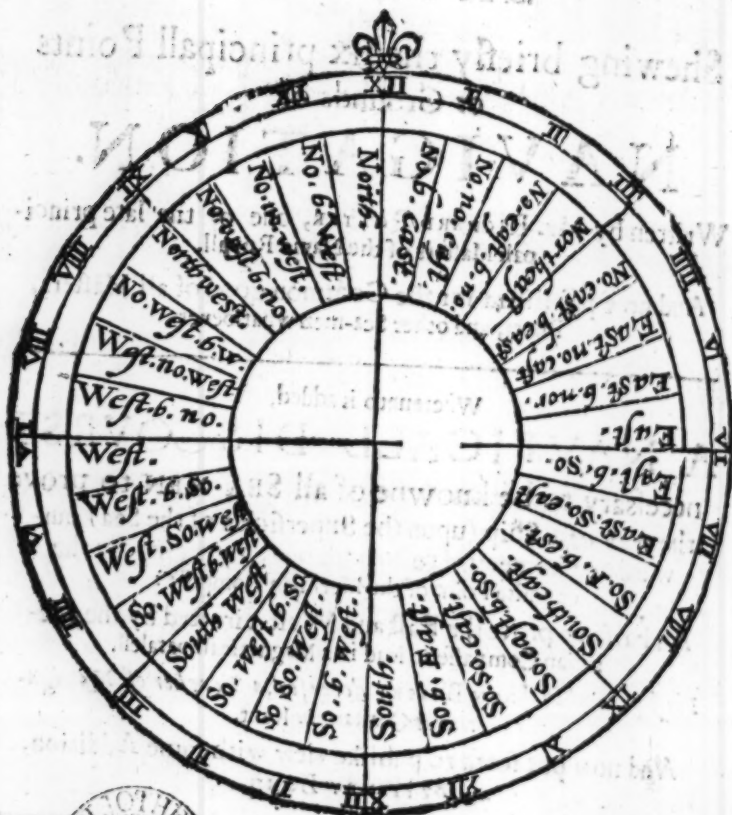
And now put forth to publike view with some Addition,  
By HENRY BOND.

---

LONDON,

Printed by T. FORCET for GEORGE HURLOCK, and are to be sold at his shop neere St. Magnus corner. 1644.

The Path-way to perfect  
SAYLING.





# THE P A T H - W A Y

to perfect S A Y L I N G.

Shewing the fixe principall Points or Grounds, concerning Navigation.

- |              |   |         |
|--------------|---|---------|
| 1 The Card,  | } | 4 Time, |
| 2 Compassse, |   | 5 Wind, |
| 3 Tide,      |   | 6 Way.  |

**I** deliver the opinions (concerning the Card and Compassse) of a great sort of Sea-Masters and others, even in these times such is their knowledge, being altogether ignorant, even vaine and frivolous, that I will not spend the time once in nominating any such their knowledge, but will proceed to the matter.

The Compassse to be rectified two wayes.

**F**irst, there is to be delivered two wayes for a mans farther knowledge, that the Compassse is to be rectified, as followeth.

The Compassse is said to be rectified when the wper is set right under the Flower-de-luce, for the Flower-de-luce and his opposite point delivereth the true Meridian.

Also, the Compassse is said to be rectified, when the wper is

## The Path-way to perfect Sayling.

set right under the Flower-deluce, the Flower-deluce and his opposite point, delivereth the true Mutation or Variation of the Compass.

Further, there are foure opinions concerning the Compass: which foure opinions and wayes conceived of the Compass, being rectified from the true Meridian that it is presupposed to lead in, which I will give a task of for this present, and so leave them to more convenient places.

### The first Opinion of the Compass.

**T**he most Absurd way of the Compass, is according to flat Cards used in Navigation: which some sort of men (and the greatest number hold opinion, that the Compass leadeth no other wise then according to these usuall Plats or Cards right lined, whose lynes generally are paralell each to other, and that the East and West of the Compass leadeth in a paralell, which opinion is absurd: so how can the thing that is false deliver the way of truth, as hereafter followeth.

### The 2 Opinion of the Compass.

This way of the Compass (in deed) which is more perfect then the former (according to the judgement of Astronomers) is called the Astronomical deducure of the Compass, and by other sort of men called the paradoxall Compass, because the lineaments are spirall: which spirall lins by some are called Helicall lines. This Astronomical deducure (as above said) some sort of men hold to be principallest. In this judgement the Meridians have their coartation, but the Compass (the East and West thereof) is said to lead in a paralell, therefore though nearer the truth then the former, yet absurd.

### The 3 Opinion of the Compass.

Is the demonstration of the Compass, which is more excellent then the two former, being knowne aright: which demonstration of the Compass, some sort of men seeth (but with heads filled with infirmities, &c.) and wanting knowledge knoweth not the meaning thereof, and but very few understand the goodnesse that is to be delivered thereby, yet the way of a ship is not according to the present view thereof.



## The 4 Opinion of the Compass.

Last of all (which fewest or none know) is the onely true and excellent way, the way of the Compass according to the difference never yet delivered by any, nor knowne unto those that make themselves most artificiallest.

I am now to deliver my reasons or examples concerning these foure opinions (above said) which are to condemne the small knowledge, opinion or judgement of men, concerning them: and to iustifie and maintaine the good knowledge that hereafter shall be delivered.

## The Card and Compass handled together.

**W**hereas, before I have delivered a taste of the foure opinions concerning the Compass, the first opinion relying onely upon the truth of the Card, Therefore it is most necessary for me, next of all to deliver the absurdities of the Card, or to lay the Card open in his colours, that when the truth thereof is seene and knowne, then that the way of the Compass (according to the Card used in navigation) may be left, and a more true way taken hold of &c. Now to proceed as followeth.

## The 1 Absurdity.

A generall Card straight or right lyned, as it is, representeth, yea delivereth the whole universall world at the view thereof, as a plaine flat or leuell and not otherwise, and maintaineth a scale correspondent thereunto, and how absurd this delivery is, hereafter is proved.

## The 2 Absurdity.

This generall Card maintaineth a Compass in the midst that shall extend it selfe, and the points thereof to the extreames of the Card, and so delivereth courses by one Compass to sayls to the extreames of the world, deliuered thereby if it were navigable, even to any part thereof, and to returne the same way againe: which is absurd, as by the demonstration and seag of the difference following is proved.

## The 3 Absurdity.

This Card will direct by halfe a Compass made on the side of the Card, over the whole world, and the returne to be the same way, which is more absurd.

## The 4 Absurdity.

Yet this Card will direct farther, that is by a quarter of the Compasse made in one of the corners of the Card, over the whole world, which will be made most absurd and monstrous by the grounds before spoken of.

## The 5 Absurdity.

This Card also maintaineth from the Poles themselves an East and West line, a Meridian and seven points of either side, whereby the North Pole delivereth from it a Southeast quarter and a Southwest quarter, and the South Pole the like, which is absurd: my reason to prove it to be so, is this, because there passeth no lines imaginary from the Poles; but onely Meridians according to the sphere.

## The 6 Absurdity.

This Card also maintaineth all the parallels of the East and West therein, to be of one length, which is absurd: for parallels are lesse towards the Poles: likewise this Card justifieth the parallels to make right angles with the Meridians even to the Poles, which is absurd, for parallels are inferior Circles unto the Meridians, which are great Circles, therefore cannot make right Angles with them.

## The 7 Absurdity.

This Card also maintaineth all Meridians to be parallels each to other, and thereby maketh a polar line of East and West in the Pole it selfe as long as the Equinoctiall, which is an error of 360 degrees, or 21 600 miles, which is most absurd: my reason is this, because the Pole it selfe is but an imaginary point.

## The 8 Absurdity.

Again, there cannot be a right signe (for the way of a Ship) delivered from the plains of a Meridian in the Card, for the delivery of the longitude, the Meridians being parallels each to other (and wrested from their nature) as they be, neither can there be a second right signe (for the way of a Ship delivered from the East and West of a Card) for the delivery of the Latitude: because the parallels therein cannot deliver neither the plaine of a great Circle nor small: therefore the Card absurd.

## The Path-way to perfect Sayling.

5

### The 9 Absurdity.

Likewise, this presupposed way of the Compass, according to the Card delivereth vpon any point of the Compass, for any Segment in Navigation a lesse way in Longitude and Latitude then the Astronomical deduction of the Compass, or way vpon the difference doth but if the Longitude of this first way be compared and reckoned after the coarting of the Meridians for any segment in Latitude and Longitude: then it is more swifter in Longitude then any opinions else delivered of the Compass: therefore absurd.

### The 10 Absurdity.

All the lynes in a Card are supposed to be Segments or pieces of great Circles, which is absurd and false: for example, great Circles must crosse themselves at opposite points of necessity, and therefore cannot be parallels each to other: likewise I am sure they count them not spirall lines, for spirall lines are not parallel either to other.

### The 11 Absurdity.

The Equinoctiall and Meridian, in a Card graduated as they be by even degrees, both in Longitude and Latitude, being in plano not lawfully projected, is absurd.

### The 12 Absurdity.

Likewise, the Card delivereth this rule for his truth, vpon what point of the Compass soever, the points being of one quality, in what Latitude or Longitude soever you are in, like distances for the differences of degrees in Longitude: which is absurd, and confuted by the Astronomical deduction, and by the way vpon the differences.

### The 13 Absurdity.

Also the Card delivereth this for his truth, vpon what point of the Compass soever, the point being of one kinde, in what Latitude or Longitude soever: like distances for the raising or laying of a degree in Latitude, which is absurd and false, as shall be delivered by examples vpon the difference.

### The 14 Absurdity.

This Card delivereth no truth in Longitude: nor so nere the truth as is to be delivered, therefore in places that  
are

are distant from other, the difference of time in no sort is to be delibered thereby, therefore more absurd, then that which will deliver the time more certaine.

#### The 15 Absurdity.

Whereas one Compass (as before) in the midst of the Card, the point thereof being extended to the extreames thereof, and west there, it is as contrary to the truth as falshood is; for the points of the Compass being extended in delatation but to the Quadrant, which is 90 deg. according to the demonstration in plano, not lawfully projected, is absurd.

But some of the points to be extended (without) or beyond the Quadrant 105 deg. too much, and continued in delatation, is absurd, but a halfe Compass in the East or West part of the Card, as the Card delivereth, some of which points, from his halfe Compass being extended from the Quadrant in delatation 176 deg. 45 min. too much, is more absurd. Say a quarter of the Compass delivered from one corner of the Card, as the Card delivereth, some points thereof are extended in delatation beyond the Quadrant 300 deg. (of a great Circle) too much, which is most absurd, as the 15 part in the Astronomical deduction, and first part of the demonstration sufficeth.

#### The 16 Absurdity.

Whereas in this Card, the Compasses in the midst, does at corners thereof, extending their delatation and coartation accordingly beyond the quadrant, as aforesaid, which is absurd: yet the delatation and coartation within the quadrant, is also absurd: as for example; Prove from the center of any of the Compasses in the Card, at 30 deg. delatation, and see whether the degrees there, be halfe so big as they are in the quadrant (as they should be) or no, and you shall find 3 of the deg. there, at 30 deg. delatation, to make but a degree in the quadrant, which is  $\frac{3}{4}$  part false: but it delivereth at 45 deg. delatation 2 deg. there, to be 1 deg. on the quadrant, which delatation is  $\frac{1}{5}$  deg. false, or out of his due place.

#### The 17 Absurdity.

It is a great matter, how absurd the Card is: for let a Ship in her navigation in any Longitude or latitude whatsoever, saile in the lyne of North-east or the like points, as North-west and South-west, before she can accomplish one Quadrant, she must  
vfe

## The Path-way to perfect Sayling.

7

use so much way in her navigation, as cometh to 137 deg. 15 min. of a great Circle, which is 37 deg. 15 min. too much onely in that distance: but a quadrant according to the Sphere is about 90 deg. of a great Circle, which is the truth: therefore the Card absurd.

The 18 Absurdity.

A Ship in her navigation differing in longitude according to the Card altereth the pole from the first place on the polar line to the meridian on the Card which the Ship is said to be in, which is absurd, as by the 18. part in the Sphere is justified.

The 19. Absurdity.

It is a verballie that the Card (being so monstrous) flowing with nothing but absurdities that one error thereof being as example (as aforesaid) should be so great in request as it is, being no life or helpe in the world in it to that which is god in navigation: how it is possible for the Cosmographie, Geographie or Geomaty thereof to be true: surely in this Card the one is as true as the other and no truer: therefore all false and absurd.

So that the Compass is wrested from the good nature it hath in it selfe for the delivery of a ships way, by the absurd opinion delivered to be or received from the Card.

If I could alleadge more condemnations for the Card and the opinions of the compass (being accordingly) yet enough sufficeth, to witte the matter in the Card (and knowledge thereby received) were better: And thus I leave the Card and the judgement by it of the Compass.

## The Sphericall Description of the Globe, with the Astronomical deduction of the Compass accordingly which by some sort of mean is called the paradoxall Compass.

**N**OW will I proceed with the Astronomical deduction of the Compass: and because it dependeth upon the lineaments of the Sphere which is the ground thereof, as the Card is of the Compass, used thereby in navigation therefore I will entreat somewhat concerning both the Sphere and deduction of the compass upon it: and as there are 19 absurdities

ties before delivered, for the confuting or delivering the Card in his colours: so many parts I will touch in this Astronomical deduction, that the difference (between them) may be scene. But this in briefe by the way: The Astronomical deduction cleareth a way from it many absurdities, by coarting of the Meridians (onely) it maintaineth absurdly the East and West of the Compass, to lead in a paralell as herafter shall appeare.

The 1. part.

**T**his whole description of the world, in Globe or round some spherically lyned with meridians (one being graduated) likewise with paralels and spirall lines, which by some men are called Rhombes, by others called Helicall lynes, and by some called Paradorall lines, set downe with the Geographie, the scale thereof being the graduated meridian, which is correspondent thereunto, is very profitable to the knowledge thereof, and confuteth the flat Card.

The 2. 3. and 4. parts.

This Globe maintaineth a Compass, being in the Zenith of the earth and water, to extend it selfe according to the demonstration in delatation to the Horizon and no farther: deviding it into 32 parts or points correspondent thereunto, but maketh the way of a Ship out and home to be all one, and spirally according to this Astronomical opinion, that the East and west of the Compass leadeth in a paralell is absurd, and causeth great difference, which in this place and time cannot be delivered.

The 5. part.

This Globe maintaineth the Poles of the world, to be but imaginary pyicks or points, delivering, or from which points proceedeth onely meridians, which is true.

The 6. part.

This Globe maintaineth all the paralels of Latitude therein, to be in their due forme, proportion, or Magnitude biggest nearest the equator, and smallest nearest the Poles, disallowing paralels, to make right angles with meridians, which is true.

The 7. part.

In which Globe, likewise the meridians hath their delatation and Coartation, admitting no polar line, which is true.

The 8. part.

This Globe, according to the East and west, leading in a Paralell,

parallell, delivereth one right signe (for the way of a Ship) from the plaine of the meridian (as it should) for the delivery of the longitude the difference respected, and the other right signe, from the plaine of the parallell for the delivery of the latitude, which is absurd: for if the plaines of a great Circle and a small, to deliver the place of a Shipp being, agreeth not, neither is true, as the difference justifieth.

The 9. part.

The way of the compasse, according to this astronomieall delivery, for any segments in navigation upon what Point soever, is more swifter in latitude, and more slower in longitude, then the delivery used in navigation by the Card, delivering the point of a Shipp being, by the signes as aforesaid, which is absurd.

The 10. part.

This opinion of East and West, leading in a parallell, delivereth no segments of any spirall lines, to be segments of great circles, which is absurd.

The 11. part.

The Equinoctial and meridian, in the Globe graduated as they be, by even degrees both in longitude and Latitude, being in round Globe forme, is very true.

The 12. part.

This opinion delivereth upon any spirall line (of one quality) which are the points of the Compasse, according to this judgement, not like distances for the difference of degrees in longitude, but is different in every place betwene the equator and the poles yet not the truth, as the difference justifieth.

The 13. part.

And for this Astronomieall delivery by any the spirall points thereof, to raise or lay degrees in latitude: it differeth little from the card, which is absurd.

The 14. part.

This Globe, the meridians thereof delivereth or distinguisheth it selfe into degrees of longitude, by which degrees is delivered the difference of time betwene any two places or distances, yet not very true, as in the delivery of the time shall appeare.

The 15. part.

As by this Globe (before) the compasse according to the demon-



frature from any one place, delibereth delatation to the Horizon where it is greatest, so from the Zenith or horizon to the Nadir, all the Arches of depression suffer coartation, so that the intersections or crossings of those points of demonstrature, are in the Zenith, and his Nadir, which is true: therefore the 15 absurditie in the Card proved by this to be most absurd.

The 16. part.

By this Globe a compasse in the Zenith thereof delibering the Azimuthes to the horizon which is at 90 degrees from the Zenith you shall find these Azimuths at 30 degrees delatation, Where 2 degrees maketh 1 degree in the horizon, and all the rest of the Azimuthes or degrees of them, is delivered with truth, either in delatation or coartation, therefore the 15 absurdity in the Card is acknowledged.

The 17. part.

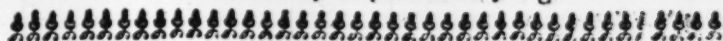
This Globe delibereth by any point of demonstrature, 90 degrees and no more to the quadrant, therefore confuteth the Card according to the 17 absurdity.

The 18. part.

This Globe maintaineth the poles of the world to continue in their places which is true.

The 19. part.

The Cosmography, Geography and Geometry, of the Globe, is farre more perfect then that in the card, yet if the Cosmography and Geography were set downe according to the difference, it would be more perfect: but then there must be more descriptions then one: and thus I leave the Astronomicall Iudicature of the Compasse. This alwayes to be noted, looke what Instrument is said to be in the Sphere of the Heavens, as meridians for the delivery of the time, and a helpe for the delivery of the Longitude, the equinoctiall and all the paralels, for the delivery of the latitude, the horizon, and all the Almucanters of Altitude, for the delivery of heights, the verticall circles or Azimuthes, for horizontall distances, spirall lines, according to the difference for the delivery of a Ships way and such like: is imagined to be in the earth and waters, correspondent to these in the Heavens, for the travellers help and comfort: the conceit of which aright, is most excellent.



Heere followeth the demonstration of the Compasse, which is a notable knowledge and light in Navigation, being rightly conceived and used as it ought.

## The 1. part.

**I**n any latitude and longitude whatsoever, the demonstration of the Compasse representing as it doth, the Zenith of the earth and water, and divideth the horizon, not onely into 32 parts, as in the 2. 3. and 4. absurdities of the Card is set downe, but also into 360. parts, nay rather into infinite parts called verticall Circles or Azimuthes going with declination from the Zenith or Verticall point to the horizon where the declination is greatest, and from this horizon or Zenith to the Nadir (as is said in the 15. part of the Astronomical deduction) these Azimuthes or Verticall circles (in the Hemisphere, not scene, being arches of depression) suffer contraction, so that the intersections or crossings of these Azimuthes one another, is onely in the Zenith and his Nadir.

## The 2. part.

This demonstration is moveable or alterable, according to a Ship differing in longitude and latitude, because a Ship carrieth her Zenith with her, so that the division of the horizon according to this demonstration is variable, according to the distance (from any one place) that the Ship is removed: &c. A confuting of the 2. absurdity of the Card.

## The 3. part.

The division that the Zenith, horizon and Nadir hath, or is divided withall, is onely by almicanter circles, which otherwise are called circles of Altitude or height (being above the horizon) all which are paralels to the horizon, but those from the Horizon to the Nadir, notwithstanding paralell to the Horizon are circles of depression, any one of which Almicanter, may be delivered upon any degree or minute of the height above the Horizon, likewise taken (in some working spherically) in profundity and depth under the Horizon.

## The 4. part.

This demonstration delibereth upon any Azimuth whatsoever, the distance from the Zenith to the Horizon to be but 90 degrees.

## The 5. part.

The East and west of this demonstration (from the zenith) 90 degrees in longitude, toucheth the Equinoctiall, in the horizon at opposite points.

## The 6. part.

Now the quality of the Globe is this, the pole thereof being elevated or set to his purposed latitude in his horizon, according to this demonstration, delibereth the obliquitie of the Sphere, which in truth is a confuting of the East and west to lead in a paralloll: as for example.

## The 1 Example.

The Globe set to the paralloll of 50 degrees north latitude, then a perpendicular line imagined to descend, from this Zenith of 50 degrees North latitude, delibereth his Radir to be in 50 degree South latitude, so that it delibereth the opposite part of the paralloll to be from the Radir or the arch of the meridian, contained betwene the opposite part of the paralloll and the nadir, to be a 100 degrees oblique or different, and from the place of being in the zenith upon the meridian, to the opposite part of the paralloll directly, is but 80 deg. of a great circle, so that this opposite part of the parallolls is 10 deg. above the Horizon, which is oblique to the zenith and Radir, also 90 degree North from the east and west of the demonstration, in the equinoctial. So that a Ship being in (or having) this zenith before spoken of, the perpendicularity of the ship, being in this Zenith and Radir line, and the opposite part of this Paralloll so oblique unto her, as before how is it possible, for the East and West of the compass to lead in a paralloll.


## The 2. Example,

Likewise when the ship, the right line of her capping in the vertical circle of east and west extended both the wayes, crokketh the equator at opposite points, 90 degree different in longitude, and the Ship being a segment of that great circle, and no segment of a small circle as parallels are how is it possible, then for the east and west to lead in a paralloll; it is not possible as the way of the difference justifieth, &c.

## The third Example.

Being in the paralell of 80 degrees North latitude, a perpendicular line delivereth the Nadir to be in 80 deg. S. latitude, so that the arch of the meridian contained betwene the nadir and the opposite part of the paralell is 160 degrees.

But the arch of the meridian, contained betwene the point of being, and the opposite part of the paralell is but 20 degrees.

So that the opposite part of the paralell is 70 degrees above the horizon: and likewise 90 deg. North from the east and west, according to the demonstration in the equinoctial:  Here you see the obliquity of the opposite part of the paralell to the zenith, and his nadir, shewing how unnaturall it is to deliver the way of a Ship, leading in the east and west to describe a paralell.

And whereas before I have delivered the East and west of the demonstration of the Compass in the horizon, and that the north and south is likewise very plain to be delivered; therefore I will omit them: and will give examples of the demonstration in the latitude 51 degrees 30 min. and 30 degrees North latitude, only of the north-east, south-east, south-west, and north-west to the Horizon, as hereafter followeth.

North-east in the Latitude 51 Degrees 30 Minutes.

From our point of being in our Meridian, which is the beginning of our longitude, our Zenith being in the paralell of 51 degrees 30 min. north latitude: I am to demonstrate 3 segments of a great circle, containing 30 degrees a peece by the demonstration north-east: the end of which first segment of 30 degrees, shall touch the Meridian in longitude East-ward, 54 degrees from the first, and there likewise shall touch the paralell of north latitude 64 degrees.

And the end of the second segment of 60 degrees in longitude shall touch the 105 degrees 30 min. Meridian in longitude east-ward from the first, and there likewise toucheth the 50. deg. 30. min. paralell north.

Likewise the end of the third segment, at 90 degrees in longitude, shall touch the 148 degree Meridian in longitude East-ward from the first, and there likewise toucheth the 26 degree 15 min.

\* If the  
style upon  
vertical  
of East or  
that the  
pass doth  
when it  
begins its  
but as the  
is guided by  
magnetic  
Wiers or  
dile, so tha  
Line of its  
makes equ  
Angles wi  
very mag  
call Merid  
The way  
ship leadin  
the East or  
doth descri  
magnetic  
ralell.

ward 15 min. paralell South: also it there toucheth the horizon 45 deg. either from the cardines East or South.

North-west.

Likewise the demonstration of the South-west cutteth the meridians and paralels in longitude West-wards as the demonstration of South-east cutteth them East-wards, onely that it cutteth the Horizon 45 deg. either from the cardines West or South.

South-east in the same Latitude 51 deg. 30 min.

**I**n our place of being (as aforesaid) I am to demonstrate three segments of a great Circle containing 90 deg. a piece by the demonstration South-east, the end of which first segment of 30 deg. shall touch the 23 deg. 30 min. or Meridian in longitude East-ward from the first, and there likewise toucheth the 27 degrees 30 min. paralell South.

And the end of the second segment of 60 deg. in Longitude shall touch the 37 deg. 40 min. or meridian in longitude East-ward from the first, and there likewise toucheth in 6 deg. 25 min.  $\beta$ . latitude.

Likewise the end of the third segment at 90 deg. in Longitude, shall touch the 51 degree 40 min. or meridian. in Longitude east-ward from the first and there likewise toucheth the 26 deg. 15 min. paralell South: Also there toucheth the Horizon 45 degrees either from the cardines East or South.

South-west.

Likewise the demonstration of the South-west toucheth the meridians and paralels in longitude West-ward as the demonstration of South-east toucheth them east-ward, onely that it cutteth the horizon 45 deg. either from the cardines South or West.

Examples in the Paralell of 80 deg. North latitude beginning with the first example of North-east in the north latitude 8 deg.

**F**rom our point of being, in our meridian which is the beginning of our longitude, our zenith being in the paralel of 80. deg. north latitude I am to demonstrate; segments of a great circle, containing 90 deg. a piece by the demonstration north-east the end of which first segment of 30 degrees, shall touch the meridian in longitude east-ward 19 degrees 20 minutes from the first, and there likewise shall touch the paralell of South latitude 60 deg.

And

And the end of the second segment .160. deg. in longitude shall touch the 120. deg. 0. min. 02 meridian in longitude eastward from the first, & there likewise toucheth the 36. deg. 45. min. parallell north.

It likewise the end of the 3. segment at 90. deg. in longitude shall touch the 134. deg. 30 min. 02 meridian in longitude eastward from the first, & there likewise toucheth the 7 parallell north. Also there toucheth the horizon 45 deg. either from the cardines east or north.

North-west.

It likewise the demonstration of north-west cutteth the meridians and parallls in longitude westward, as the demonstration of north east cutteth them eastward onely, that it cutteth the horizon 45 deg. either from the cardines west or north.

Example of the South-east in the same Latitude 8. deg.

For our place of being, (as aforesaid) I am to demonstrate three segments of a great circle, containing 30 deg. apiece, by the demonstration south-east, the end of which first segment of 30 deg. shall touch the 35 deg. 40 min. 02 meridian in longitude eastward from the first and there likewise toucheth the 52 degree 10 min. parallell north.

And the end of the second segment of 60 deg. in longitude shall touch the 41 degrees 40 min. 02 meridian in longitude eastward from the first, and there likewise toucheth the 22 degrees 0 min. parallell north.

It likewise, the end of the third segment at 90 deg. in longitude shall touch the 45 deg. 30 min. 02 meridian in longitude eastward from the first, and there likewise toucheth the 7 parallell south. Also there toucheth the horizon 45 deg. either from the cardines East or south.

South-west.

It likewise the demonstration of south-west, cutteth the meridians and parallls in longitude westward, as the demonstration of the south-east cutteth them eastward, onely that it cutteth the horizon 45 deg. either from the cardines south or west.

And as for the arches of depression, from the horizon or zenith to the nadir of these points before spoken of, the delivery of them is even as easie as the former, and so is the arch of altitude, or arch of depression upon any Azimuth whatsoever. Onely this

follows.

following to be respected as a preparative : before I deliver any nice examples according to the difference, it is necessary for me to explain in a more familiar sort (at large) some part of the difference onely according to the demonstration, for the more confuting of the Card, and the opinion holden thereof for the way out and home to be all one. It is delivered in the absurdity of the Card, that upon some points of the Compass, the Card delivereth a way outward, to be 390 degrees of a great circle, and to returne homeward (to the first place) againe, the like distance upon the same line, which shall be proved most false by the examples following : which examples shall be from the latitude of 50 Degr. and from the first example, as before in the latitude 51 degrees 30 min. yet these deliver not the truth neither, as by examples upon the difference, hereafter follow.

The 1 Example in North Latitude 50 deg.

**I**n which latitude, our Zenith or place of being in one meridian, where we make our beginning of longitude and place of departure; I am now to deliver from this our Zenith or place of being, the demonstration of north-west for one segment of 30 degrees in longitude : which segment end of 30 Degr. North-west, there cutteth the 51 Degr. 30 minutes or meridian westward in longitude, and the 63 degree paralell north.

Our Zenith now being altered and the latitude 63 degrees as aforesaid, we will make prose to returne back againe to our first place by the line south-east the like segment of 30 degrees in longitude, where this segment end cutteth the 26 degree 20 minutes or meridian in longitude eastward, and there likewise cutteth the 37 degree 40 minutes paralell north.

So that this line of north-west extended to 30 degrees as aforesaid, and from thence returning south-east to 30 degrees likewise there is difference in longitude westward, from the first meridian or place of departure 15 degrees 10 minutes or meridians, and in latitude southward from the first 12 Degr. 20 minutes.

Here you see the difference of the way out and home, onely for 30 degrees according to the demonstration, and onely for the lines of north-west and southeast; the rest of the points, hath their like difference in their kind.



The 2. example in north Latitude 51 deg. 30 min.

**I** Am now to deliver from this our Zenith or place of being, the demonstration of the north-east to 90 deg. which line of north-east there cutteth the 128 degree or meridian in longitude eastward from the first, and there likewise cutteth the 26 deg. 13 minutes paralell north, as in the demonstration is delivered.

Our Zenith now being altered, and in the latitude 26 deg. 13 minutes as before said, we will make a passe to return back again to the first place, by the demonstration south-west to 90 deg. where this line of south-west cutteth but the 65 deg. 30 minutes meridian in longitude westward and there likewise cutteth the 39 degree 30 minutes paralell south. So that this line of north-east extended to 90 degrees as aforesaid, and from thence returning south-west to 90 deg. likewise, there is difference in longitude eastward from the first, 62 degrees 30 minutes, and in latitude southward from the first 91 deg.

Here you see also the difference of the way out and home, only for 90 deg. according to the demonstration, and only for the lines of North-east and south-west, and all the rest of the points is the like in their kind. And so I leave the demonstration.

Now will I deliver Examples worthy the noting, of the way of the Compass according to the difference.

**T**he East or west of that Compass, rectified to the true meridian upon the difference, maketh a spirall line in dilatation to the equinoctiall from what paralell soever, by segments (of great circles) correspondent for this purpose: which segments maketh right angles with the meridians, and which segments delivereth a right signe from the plaine of the verticall circle of east & west for the way of a ship in her navigation, and the meridian according to this difference delivereth the other. This part of the difference only confuteth the generall Card and the lines of inclination, with the Geography of the Globe.

This difference, the east and west thereof delating as aforesaid, ruleth notwithstanding the variation of the Compass, generally spoken of, as for example: the Compass here with us at London, is set at halfe a point variation Eastward, where it should be 10 degrees 38 minutes 45 seconds by my owne obser-

bation, (which was made in the yeere 1586,) which maketh the west to be halfe a point to the north-ward of the west: therefore in going from Silly (which is in latitude 50 degrees 15 minutes) or thereabouts) west by the Compasse (which is in truth west half north) with Cape Race, in New-found-land the places distant some 600 leagues from other, causeth a sailing more southerly into the latitude 46 deere 30 minutes) or thereabouts; which sheweth the way of the difference to rule in this distance.

And by a Compasse rectified to the true meridian, that is a Compasse that the north and south thereof, delivereth or pointeth according to that true meridian of Silly, on which meridian is delineated the arch of altitude or almucantar of the Sunnes height at noon, by which, or such, Compasse, Cape Race beareth from Silly due west and by north, and there toucheth the paralell of north latitude 46 degrees 30 minutes, likewise toucheth the meridian in longitude westward from Silly the 45 degrees 40 minutes according to the counting of the meridians in this distance.

And to speake the truth, in this distance there is but little or no variation of the Compasse to be respected; for the compasse at Silly set at the whole variation as it ought to be, yet in sailing by that compasse, you runne some 400 leagues before the north and south points thereof, delivereth the true meridian; and in sailing the other 200 leagues, the compasse is varied westward a point and a halfe or thereabouts, which is no more then will answer the variation eastward, as before, so that in this distance, the mutation of the Compasse, eastward, & westward, considered aright, is as nothing to be respected, (but the one set against the other,) as by the examples following is proved.

#### The first Example.

Let a compasse be rectified to the mutation, and sayle from Silly therewithall to Cape Race, west: & when you come on the coast of Newfoundland you shall be delated from the paralell of Silly, only according to the difference, and not otherwise.

#### The second Example.

Let the compasse be set at halfe a point mutation, as most commonly it is, and sayle by the Compasse from Silly west with Cape Race, and you shall perforce (keeping that course directly) fall into more southerly latitude, which is into 46 degrees 30 min.

## The Path-way to perfect Sailing.

19

or thereabouts, according to the difference, and not otherwise.

### The third Example.

Let the Compass be rectified to the true meridian, and sayle by that Compass from Silly west with Cape Race and you shall likewise fall into the latitude 44 degr. or thereabouts, according to the difference.

And as for this way (abovesaid) is delivered a delating from the paralell in going west: so likewise in returning east frō thence againe, you shall likewise delate from that paralell againe, according to the difference: which delivery overthroweth the whole Card.

Again, looke how the difference of the east and west ruleth in the distance and difference in longitude (as also said) so in any other distance and difference in longitude, it is likewise to be respected. Also this difference of the east and west, is the ground frō whence the difference is delivered, for all the rest of the points of the Compass.

So that you see, this way upon the difference, delivereth way outward to any place, different unto the way homeward, being not both alike, as by the examples of the north-east, and returning south-west: likewise of the north-west, and returning south-east, as hereafter appeareth.

### The 1 part of the 1 example from the Equator.

Being in the Equinotiall in any one meridian, I will there make my beginning of longitude: from which equator, and meridian of longitude, I will deliver the line of inclination, northeast continuing it to the latitude 75 degr. 6 minutes 14 seconds according to the difference.

### The 1 part of the 1 Example.

The line of the north-east continued to the latitude 75 degrees 6 minutes 14 seconds, according to the difference, endeth in the longitude 131 degrees from the first, reckoned according to the meridians in this distance coasted.

### The 3 part of the 1 Example.

Being in the latitude 75 degrees 6 minutes 14 seconds, and in the longitude 131 degrees as also said, I am now to returne back againe by the line of inclination, south-west to the Equinotiall.

Conclusion

## The Path-way to perfect Sayling.

Conclusion of the 1 Example.

Being returned to the Equinoctiall as aforesaid, I doe find the length of the line of inclination south-west homeward, to be 20. After then the line of north-east outward, by 130 leagues, and I am in longitude eastward from the first place on the Equinoctiall 70 leagues, therefore the way out and home not all one.

Another Example North latitude 50 degrees.

I sayle north-west 50 leagues, at the 50 leagues end I have altered my longitude from the first, 2 degrees 38 minutes, and my latitude 1 degree 40 minutes.

I returne back againe south-east 50 leagues, and being returned, I find my selfe in lesse longitude or westward from the first, 3 minutes, and in latitude more then the first 6 minutes.

Another Example in the North latitude 60 degrees.

I sayle north-west 50 leagues, at this sagment end, my longitude from the first is 3 degrees 30 minutes, and latitude from the first 1 degree 50 minutes, I returne back againe south-east 50 leagues, and being return'd, I find my selfe in lesse longitude or westward from the first, 5 minutes, and in latitude more then the first 10 minutes.

And so; the more confusing of the way out and home to be all one, and the more justifying the delating from the paralell to be true, I will deliver some more examples vpon the east, for a sagment of 20 leagues, in the latitude 51 degrees 30 minutes, and 75 degrees, delivering the horizontall distance betwene the east (according as is said) to lead in a paralell, and the way of the east according to the difference, as followeth.

In Latitude 51 deg. 30 minutes, my first place.

From any one meridian of longitude, I take a sagment of the paralell in this latitude of 20 leagues, presupposed by some to be East from the first place: and againe, I doe depart from my first place of being 20 leagues eastward according to the difference: now at this 20 leagues end, I am delated from the paralell according to the way upon the difference, which maketh my place (now of being) to beare from the first place, two Azimuthes, and more southerly.

As for Example.

To explaine it more bytely, I imagine one lyne from the first place

place east, according to the paralell 20 leagues : imagine another line from the first place East by the Compasse, according to the way upon the difference : now the horizontall distance betweens these two lines at 20 leagues end, from the first place, shalbe (as before) two Azimuths.

In the latitude 75 my first place and meridian of longitude, I take a segment of the paralell in this latitude, of 20 leagues, presumed likewise by many to be East from the first place : and againe, I doe depart from my first place of being, 20 leagues east, according to the way upon the difference : now at this twenty leagues end, my horizontall distance betweens my place of being, and place (as aforesaid) on the paralell, from the first place, is 3 azimuths.

Likewise this way of the difference delibereth upon any Azimuth, or point of Compasse, segments of great Circles, different from other, correspondent as they ought to bee, for the difference in longitude as hereafter by three examples of the North north-west following appeareth, which confuteth the absurdity of the Card.

Three Examples of the North North west, for the difference of the length of the Segments in longitude from the Equinoctiall, to 80 degrees in latitude, as followeth.

The first Example from the Equator.

**B**eing in the Equinoctiall in one meridian, the segment of North-west to reach to the next meridian which is one degree in longitude, is in length 52 leagues.

The 2 Example from 40 deg. of latitude.

Being in 40 degr. of latitude, and in one meridian, the segment of north north-west, to touch the next meridian, is in length 37 leagues.

The 3 Example from 80 degrees of Latitude.

Being in 80 degrees of Latitude, and in one meridian, the segment of north north-west, to touch the next meridian, is in length 3 leagues.

Also, this way of the difference delibereth upon any Azimuth or point of the compasse, segments of great circles, different from other

## The Path-way to perfect Sayling.

other, for the laying or raising of a degree in latitude whatsoever, as by 3 examples of the west, north west following appeareth, which confuteth the 13 absurdity of the card.

The 1 example from the Equator.

I being in the equinotall, am required to deliver a segment of the west north west, onely to raise a degree in latitude, which according to the difference is 52 leagues and 7.

The 2 example from 40 deg. of Latitude.

I being in 40 degrees of latitude the segment of west north west to raise a deg. in latitude upon the difference is 56 leagues.

The 3 example from 80 deg. of Latitude.

I being in 80 degrees of latitude the segment of a west north west, to raise a deg. in latitude upon the difference is 60 leagues.

And thus will I leade the way of the Compass upon the difference for this time.

And because the variation, or nutation concerneth the compass and is a thing delivered in print, meant belike to some purpose: therefore I will touch this variation, or nutation, in some few words as hereafter followeth.

If a man for his delivery of the variation in print, should observe by a needle touched by some, who maketh the common or ordinary Compasses, I take it, precise fellows, would some be deliberating forth, that the variation so set in print, were wide from the truth.

Because with some men in the touching of a Needle, or Compass, though the Stone they touch withall be not, the best, neither shall an inch in breadth of the north part of that Stone, breake any square with them, by whose compasses many time shipping at the Seas be endangered.

It were better for a man for the security of his charge, or that purposed to set down the variation in print, to take a needle touched by a better Stone and a more perfect man to handle the touching thereof: truly when Robert Norman dyed (who had a good Stone) Sea men had a great losse, yet Walter Mullinax of Lambeth, who having a better Stone was as carefull & as precise in his business, concerning the touching of Needles, & Compasses, as Robert Norman was.



Notwithstanding the variation (by such a good *Steele*) set down in print and delivered as a generall thing, would be but jested at: and made a thing indeed that a man might spend much time to no purpose and lesse edifying to the Seamen as some have done: my reason is this, because this Stone (though a notable one) and I have not seen a better, and good to make observations withall to be kept to a mans selfe, or out of print or for the amplyfying of some note in writing: *¶* It cannot deliver the variation of another Stone; for in truth the Variations delivered by many stones are different: you shall not have two Stones alike qualified, or that will deliver one or a like Variation, but the variation of every stone differeth from other: there cannot generallly be set downe a certaine variation for any one place, which let suffice for this time.

Wherefore that man that was contented to set the Variation in print, as a generall thing: though it were my selfe, all things to nothing, I would there in my deliberie, likewise bee condemning all mens knowledge saving my owne, to justify my doings.

But to the matter, the variation or nutation of the compasse as it shall at any time or place be found, is a thing to be noted, yet my deliberie is of it, that it is not surpassing all other knowledge, neither the overthrowth of good knowledge, neither will I accept of it as a thing notable above all the rest, my reason is this, because the way upon the difference, being more excellent, over ruleth it, which indeed they impute to variation, which is untrue: and thus will I leave the nutation of the Compasse.

And whereas before in my deliberie of the nutation, I had forgotten to give a task of the error, which is likewise set in print, and conceiveth the nice delivery of the said nutation: I thought it now therefore good (though late) not to overpasse it but to give knowledge thereof: it is said that the middle point betwene any two Azimuthes observed upon equall elevations in forenoon and afternone, is the true Meridian.

For the confuting hereof I will deliver you an example in the north Latitude 51 degrees 32 minutes as followeth.

The Sun being in her swift declination, in or nere the Equinox, I purpose to make two observations: the former observation to be 2 min. before 8 of the clock in the forenoon, the Altitude

\* This is to passe in mistaking true place the Poles of Stone, for Master G brand, and others with observing variation two severall Needles to be ed with two verall Stone found the variation to be the same, the like I have scene before since. H.B.



ter delivered then by the center of the Sun, being 18 deg. in elevation, & the horizontall distance eastward from the true meridian delivered by the Azimuth of the Sunne to be 66 deg. 38 min.

The second obseruation in the afternoon, the Sunne having the same Almicanter 18 degrees: the declination increasing respected, for 8 houres, which is 8 min. North declination, maketh the time to be 3 min. after 4 a clock in the afternoon, where in there is a min. of time different from the South and the horizontall distance westward from the South, to be 66 deg. 53 min. So that I find this last obseruation to be farther from the true Meridian, then the former by 15 min. but if the declination were decreasing, then the last obseruation will be nearer the true meridian then the former by 15 minutes, which maketh a difference of variation, sometime too much, or sometime too little, by 15 minut. good, which is an error and therefore not the truth.

Concerning the Tides.

**E**ven as mens minds for the most part are settled in the absurdities of the Card and compasse accordingly, so are they settled likewise in an absurd reckoning of their Tides, as hereafter by the grace of God shall appeare, divided into two parts, first by the delivery of the Epact, next according to the time obserbed, by the point of the Compasse, as followeth.

The first part.

These men doth not only know the prime by the date of our Lord, and the Epact by the prime, and the day of conjunction by the epact which is tollerable, according to the order of the Epact, allowing 30 dayes to every Mone: or on the 30 day end, to be Conjunction, which is notwithstanding partly at random, being without respect of the precise time of the conjunction.

But they iustifie also the departure of Sunne and Mone in 24 houres to be continually 48 min. as though the motions of the Sunne and Mone continued all one, or that 48 minut. were their meane departure.

For they bring the 32 Points, every point being a 11 deg. and a sunder, the whole being 260 deg. to 30 whole dayes, allowing for every 24 houres the departure to be (as aforesaid) 48 min. for 35 times 48 minutes is 24 houres: and 4 minutes of time is answerable to one degree of the equator: therefore the departure

parture is 12 degrees in 24 houres, allowing the just revolution of the Equator to be in 24 houres, neither more nor lesse, for 30 times 12 degrees is 360 degrees, in which their reckoning in my conceit, the course of the Sunne in those 30 daies, which is about 29 degrees 30 min. is forgotten or not respected, but either they must of necessity, grant that the revolution of the Equator, and the departure of the Sunne and Moone, to be as hereafter shall be delivered: or else they must allow the Moones error in her pererely course, to be 5 daies 15 houres 2 minut, too much, which is an absurdity, and maketh the sinodical error more then it should be by 12 houres, 15 minut. 56 sec. 49 thirds, but if they doe acknowledge, (which I take it, is in selfe or none of their heads) that the whole revolution of the Equator is turned about in 24 houres, (as hereafter shall be delivered) and so doe reckon the odds time, to be for the meane course of the Sunne in the 30 daies, yet they must acknowledge by that reckoning, that the conjunction of the Sunne and Moone, must happen almost at like times of every yere, or at leastwise, make the difference sooner of the yeerely period of the conjunction, to be but 5 daies 6 houres 9 minutes, which indeed should be 10 daies, 21 houres, 11 minutes, as hereafter shall be delivered.

The 2 part.

1 Also these men I justify in reckoning their Tides, in what place and time soever: that where it floweth a southeast moone in conjunction or opposition (and possible by a false Compass) then it floweth till 9 a clock: or where it floweth an East Moone in conjunction or opposition then it floweth 6 a clock, & so its their judgements generally of all the rest of the points of the Compass.

2 And to justifie my sayings to be true, they have set forth, printed tide tables thereof, and in those tables also, have set their judgements, that in conjunction or opposition it floweth 48 min. after the time upon any point as aforesaid, which is absurd.

Therefore these their judgements, for the security of their charge, had as much need of refining as the East and West of the Compass, as is said before, to lead in paralell.

Now to the matter, for the refining of the first part as aforesaid, let this first part following suffice.

To know the times of the Conjunction otherwise then by the

**E**pact, is delivered by Ephemerides, or Almagests, but rather knowne by that man that hath the knowledge himselfe in the Theorickes of the Sunne and Moone: which knowledge ought to be in a man that would be artificiall to refine these absurdities.

In Metheges Astronomie the motions of the Sunne and Moone are distinguished into three parts; Slow, swift, and meane: that is to say; in Apogeeum slow, when they are farthest from the earth: in Perigeum swift, when they are nearest the earth: and in their meane betwene the Apogeeum and Perigeum, notwithstanding by these three motions there is knowledge understood, that the motions of the Sunne and Moone are alwayes different, that is to say, the Sunne from this place in Apogeeum, to his Perigeum: likewise the Moone from her Apogeeum and Perigeum, of her epicycle, from her Apogeeum in her almost an oval forme of the center of her Epicycle, to her Perigeum thereof being the like qualified.

To iustifie the motions to be the truer: it is also delivered in this Astronomy, that the Sunne hath three Dybes or particular Spheres, as followeth.

First an Eccentricke which is called the difference of the body of the Sun, second is called the difference of the Apogeeum of the eccentricke, the which 2 doth containe the eccentricke betwene them: and 3. maketh the whole sphere of the Sun to be concentrick. I could delate more of this theoricke then I purpose, but it would be to small effect, concerning the tides, only respect this that followes.

Three reasons to be delivered for this Hypothesis

as aforesaid to be true.

1 First reason which causeth the Sunne to be in an eccentricke, is the difference of the Sunnes motion: which is proved sometimes swift, sometimes slow, as aforesaid.

2 Second reason is, because the Diameter of the Sunne, is proved sometime bigger (as in Perigeum 33 min. 44 sec.) then at some other time by 2 minutes 6 seconds, therfore nearer at some times then at other times.

3 The third reason is the inequality of the Epicycles, because it is proved that the Sun farthest from the earth, causeth the Eclipses to be longer and nearer the earth to be sooner.

Metheges delivereth also in his Astronomy, that the greatest eccentricity of the Sunne is 48 semidiameters of the earth.

And

And the least excentricity which is nere in this our age about the 9 degree of Cancer, is 37 semidiameters of the earth.

So the difference is a 11 semidiameters of the earth, and the semidiameter of the earth is 3436 miles and 1.

So that the sunne is nearer unto us at some time, then at some other times by 74 semidiameters of the earth.

Messine delivereth likewise, one yearely Period of the sunne to have 365 dayes, 6 hour, 9 min. 39 sec, and this yere he calleth Sideriall or Starry, the diurnall mean motion of the Sunne accordingly to be 59 min. 8 sec. 11 thirds 22 fourths 16 fifths.

The motions of the Sunne as followeth.

Her swift motion in 24 houres, is — 1 deg. 1 min. 16 second.

Her meane motion in 24 houres, is — 0 — 59 — 8

Her slow motion in 24 houres, is — 0 — 57 — 0

Messine delivereth likewise in his Astronomy, that the Moon hath five Dyas or particular Spheres as followeth:

- 1 First, an Excentricity.
- 2 Second, the difference of the Epicycles center.
- 3 Third, the difference of the excentricity in Apogee and Perigee.
- 4 Fourth, is the Epicycle which carrieth the body of Luna,
- 5 Fifth, which is Concentrick called æquans Luna.

Four reasons following to prove this Hypothesis to be true.

1 First reason which causeth the Moon to be in an excentrick, is the difference of the Moones motion, which is proved sometime swift, sometime slow.

2 Second reason, is because the Diameter of the Moon is proved sometime bigger as in Perigee 35 min. 38 seconds then at some other time by 5 min. 38 sec. therefore nearer at some times then at other times.

3 Thirdly, the inequality of the Eclipses, because the moon farthest from the earth, causeth the Eclipses to be longer, and nearer the earth to be sooner.

4 Fourthly, the inequality of the Parallax, because the Moon farthest from the earth, causeth the Horizontal parallax, to be the less, and nearer to be more.

And the greatest excentricity of the Moone is 10 semidiameters of the earth, and 2. a little lesse.

And the semidiameter of the Epicycle is 5 semidiameters of the earth and 1. So that the Moone is nearer unto us at some time, then at some other times by 30 semidiameters of the earth, and 1. and likewise by the whole diameter of the Circulus parvus: which is 20 semidiameters and 1.

For the Moone maketh a Circulus parvus, (contrary to her owne motion) about the center of the world, according to the semidiameter of the excentrick, which is 10 semidiameters, and 8 min. 30 seconds.

Likewise the Moone hath latitude of the Eliptick on either side 5 degrees, which for the tides is greatly to be respected.

Messine delivereth one meane periodical period of the Moone to have 27 dayes, 7 houres 24 minutes.

Also delivereth the meane time to make by the periodical period to a meane Anodicall period to have dayes, 2 dayes, 5 houres 20 minutes.

So that the meane Anodicall month of the Moone to be in conjunction againe with the Sunne hath dayes, 29 dayes 12 houres, 44 minutes 3 sec. 11 thirds.

The motions of the Moone as followeth.

The swift motion of the Moone, sometimes in 24 houres is 15 degrees 0 min.

The meane motion in 24 houres, is 13 degrees 30 minutes.

And her slow motion in 24 houres, is 12 degrees 0 minutes.

Now having delivered so much as needeth of the Theoricks of the Sunne and Moone concerning the Tides, we are come to the point to know their departure, which is as followeth.

The departure of the Sunne and Moone.

The Moone presently after the conjunction departeth Eastward from the Sunne in Apogeeum in 24 houres 11 deg. 3. min. which is answerable in min. to 44 min. 12 seconds.

The Moone presently after the conjunction, departeth from the Sunne in Perigeum in 24 houres 13. degrees 58 minutes 44 seconds answerable in minutes, to 55 min. 55 seconds.

The Moone presently after the conjunction departeth from the Sunne in meane motion, in 24 houres 13 degrees, 30 min. 52 seconds,

seconds, answerable in min. to 50 min. 3. seconds.

Sometimes the departure of the Sunne and Moone, when the Sunne is in her slow motion, and the Moone in her swift motion, in 24 houres, is 14 degrees, 3 minut. which maketh the departure in minutes answerable to be 56 min. 12 seconds.

And sometime the departure of the Sunne and Moone, when the Sunne is in his swift motion, and the Moone in her slow motion, in 24 houres, is but 10 degrees, 58 min. 44 seconds, which maketh the departure in min. answerable to be 43 min. 55 sec.

And the meane motion, betweene both these motions, next above in 24 houres, is 50 min. 2 seconds, 30 thirds.

Which motion is justified twice, as above: therefore I conclude the meane departure of the Sunne and moone in 24 houres to be 50. min. 3. seconds 30 thirds.

And the houely departure accordingly to be 2 min. 5 secon. 8 thirds, 45 fourths.

Stadius affirmeth in his Ephemerides, that in 24 houres the whole equator and 59 minutes 8 seconds is turned about, which is most certaine.

Like wise in a meane he affirmeth that the conjunction of the Sunne and Moone in one period, at any one time in the yeere, shall differ from the same time the next yeere, and be sooner 10 dayes, 21 houres 11 min. as for example:

In the 12 meane Anodicall moneths, the time that wanteth of 12 times, 30 dayes, is 5 dayes 15 houres 2 minutes, which maketh 360 dayes, the remainder of the dayes of the whole yeere, is 5 dayes, 6 houres, 9 minutes, which both together is 10 dayes 21 houres 11 min.

Now for the refining of th: first 2 parts, let these last 2 parts following suffice concerning their error in reckoning their tides delivering the time by the points of the Compass: for the confuting hereof, I will deliver six examples, three examples in the north latitude 30 degr. and the other 3 examples in the north latitude 51 degrees 32 minutes.

North latitude 30 degrees, the Sunne in Capricorne.

1 The Sunne at southeast, it is then  $\frac{1}{2}$  before 9 a clock in the morning, but if the Moone hath 5 degrees South latitude, then it is 24 minutes before 9 a clock: if the Moone have 5 deg. North latitude.



latitude, then it is 16 min. past 9 a clocke.

*Sunne in the Equator.*

The Sunne at Southeast, it is then 14 min. past 10 a clock in the morning: but if the *Spone* have 5 degrees south latitude, then it is 1 min. before 10: if the *Spone* have 4 degrees north latitude, then it is 30 minutes past 10 a clock

*Sunne in Cancer.*

The Sunne at Southeast, it is then 32 min. past 11 a clock in the morning, but if the *Spone* have 5 degr. south latitude, then it is 15 min. past 11: if the *Spone* hath 5 degr. north latitude, then it is 54 minutes past 11 of the clock.

And at an east Sunne, it is then 18 min. past 9 a clock in the morning, but if the *Spone* have 5 degrees south latitude, then it is 24 min. past 8 a clock: if the *Spone* have 5 degr. north latitude, then it is 46 min. past 10 a clock. So that in this north latitude of 30 degrees, there is difference of time in the *Spones* being Southeast, 3 houres. 18 min. and in the same latitude, difference from 6 a clock in the east 4 houres 40 min.

The other 3 Examples in the North Latitude 51 deg. 32 min.

*the Sunne in Capricornus,*

The Sunne at the Southeast, it is then 20 min. before 9 a clock in the morning: but if the *Spone* hath 5 degrees south latitude, then it is 18 minutes past 8: if the *Spone* have 5 deg. north latitude, then it is 11 min. past 8 a clock.

*Sunne in the Equator.*

The Sunne at the Southeast, it is then 28 min. past 9 a clock in the morning: but if the *Spone* have 5 degrees south latitude, then it is 18 min. past 9: if the *Spone* have 5, degr. north latitude then it is 38 min. past 9 a clock.

*Sunne in Cancer.*

The Sunne at the Southeast, it is then 18 min. past 10 a clock in the morning: but if the *Spone* hath 5 degrees south latitude, then it is 6 min. past 10. If the *Spone* have 5 degrees north latitude, then it is 30 min. past 10 a clocke.

But at an East Sunne it is then 22 min. past 7 a clocke in the morning, but if the *Spone* have 5 degrees South latitude, then it is



is 2 minutes past 7. If the moone have 5 degrees north latitude: then it is 42 minutes past seven a clock: likewise in this north latitude 51 degrees 32 minutes, there is difference of time in the Moone being southeast 2 houres, 2 minutes.

And in this same Latitude, difference in the east from 6 a clock 1 houre 42 minutes: the mistaking of so much time, from the high water, may overthrow their charge in going into a harbor, where it is to be respected.

2 And whereas they deliver in their Tide Tables, a hoping of the tide in conjunction, aspect or opposition, to 48 m. after the order in that Tide Table, it is not so, but in a river or in-draft, where the Tides in their prime runneth quick, there Tides of floods will runne 48 minutes after high water; and thus I will leave the relating of the Tides.

#### Concerning the Time.

Such is the conceit or knowledge of the Sea-men in these times, they take a common Compass, little respecting the error thereof, being touched with a Stone of no strength, and made wise by a man of no knowledge: which Compass they divide into 24 houres, to deliver unto them, (they observing the Sunne therewith) the time they looke for, which is as lame a delivery of the times as may be, and is somewhat touched before in the delivery of the Tides, and likewise as hereafter followeth.

Also, they observe the time by an houre, or halfe houre glasse, made by as carefull a man, as the Compass before spoken off, who indeed careth but little what error more or lesse, is delivered in those glasses in 24 houres, nay in halfe an houre, with whom (as the proverb is) an inch breaketh no square.

Which Compasses and glasses had neede to be carefully respected, nay rather to be reformed, for the security (as aforesaid) of the Navy of England, which is greatly endangered by them: and although these appendances for Navigation be more false, yet the Market-folkes being not experienced by them, in consideration of the cheapenesse of them, holding themselves thereby, profitable servants to the owner.

And although the time generally from one Moone to the other, cannot be perfectly delivered by any man, as hereafter

shall be shewed : yet by precise Instruments carefully made the time may be delivered more truly which is the greatest helpe we have in Longitude , and for a man most carefull in making of his Compasses, and running glasses , I commend Maister Emorie Mollinew of Lambeth ( while he lived ) as for my content, which I have learned concerning the time, it is as hereafter followeth.

First, for the confuting of the time delivered by the compasse, as aforesaid, which Compasse is delivered by 360 degrees, which indeed are Azimuths, and they justify as many Azimuths, which is 15 for one houre, as for another which is contrary, therefore I will deliver three examples to that effect in the Latitude 51 degrees 32 minutes as followeth.

Sunne in Capricornus.

From the Sunne rising to one houre of time, there is 12 Azimuths and a  $\frac{1}{2}$ , and from a 11 a clock to 12 at None, there is 14 Azimuths.

Sunne in the Equator.

From the Sunne rise to one houre of time, there is 12 Azimuths, and from a 11 a clock, to 12 at none, there is 18 Azimuths and  $\frac{1}{2}$ .

Sunne in Cancer.

From the Sunne rise to one houre of time, there is a 11 Azimuths and  $\frac{1}{2}$ . and from a 11 a clock to 12 at none, there is 28 Azimuths.

Also followeth two examples, the one in the north latitude 51 degrees 32 minutes : the other in the north latitude, 66 degrees, concerning the difference of time, as followeth,

The 1 Example in Latitude 51 degr. 32 min.

Aries whole signe, hath declination a 11 degrees 20 min. which reacheth in longitude Eastward, according to the degrees on the Equator, to the 28 meridian, likewise this whole signe of Aries doth lengthen the dayes 1 houre and 58 min.

Taurus, his whole signe, hath declination 8 degrees 50 min. which reacheth in longitude Eastward according to the degrees on the Equator, to the 29 and a halfe meridian : also this whole signe of Taurus doth length the dayes one houre and 44 minutes.

Gemini, his whole signe hath declination 3 degr. 18 min. which

which reacheth in Longitude eastward, according to the degrees on the equator to the 32 and a halfe Meridian, also this whole signe of Gemini doth length the dayes 1 houre 40 minutes.

The 2 Example in North Latitude 66 degr.

Aries whole signe, lengthen the dayes, --- 3 houre. and 46 min.

Taurus whole signe, lengthen the dayes, --- 3 houre. and 38 min.

Gemini his whole signe lengthen the dayes, -- 3 houre. and 0 min.

But seeing that generall time from one Pone to an other, cannot be delivered certaine, but there shall be error, so that one 24 houres shall be longer, or shorter then an other by 1 houre and 28 min. as hereafter shall be delivered: what certaine time then can be delivered by any Instruments for that purpose, which delivereth but a second error.

Now will I deliver some causes, why the time from one none to another cannot be of like time.

Messine in his Astronomy, delivereth that there is three Ecliptickes as followeth.

First, the ecliptick of the 10 Spheare which is fixed.

Second, the ecliptick of the 9 Spheare which is moveable.

Thirdly the ecliptick of the 8 Spheare which is the true ecliptick of the starry firmament.

Also he delivereth that the Sunne in Aries of the 9 Spheare, is gone to the Eastward of the Sunne in Aries of the 10 spheare, 27 degrees and better, but directly vnder it, in the same plaine.

Also that the Sunne in Aries of the 8 spheare, never is neerer to the Sunne in Aries of the 9 Spheare, then by the semidiameter of the small circle, which is 9 degrees.

Now Messine delivereth the difference of the judgements of the Astronomers, and that Ptolomy maketh the 8 and 9 Spheares all one, delivering the opinion of Ptolomy and others, as followeth.

The opinion of Ptolomie concerning the motions of the fixed starres, comparing the observations made 400 peeres before him, with his owne: he finding thereby that the fixed starres had moved in consequence 4 deg. therefore Ptolomie allowed to the whole revolution of the fixed starres, to accomplish one period, according to the rate of 36000 peeres, that was for every 100 peeres, one deg.

Messine delivereth also that the opinion of the *Alfonines*, concerning our revolution, or accomplishing of one period of the 9

Sphere is in 49000 yeeres, but according to Copernicus his observations, one periodical revolution is in 25816 yeeres, delibering that an houre of the longest Day is 63 minut. 40 seconds, such as an houre of the shortest Day is onely 60 min.

Copernicus maketh (likewise) the yeere 365 dayes, 5 houres, 49 min. 15 seconds, 46 thirds, which he calleth the yeere Tropicall, equally supputated, or counted to the middle Equinoctiall.

The Alphonines in their account, wanteth in their yeerely period 13 thirds.

Mesline maketh the yeere 365 dayes, 6 houres, 9 minutes, 39 seconds, and this yeere he calleth syderiall or starry, numbred under the Sphere of the fixed Starres, which is more then the yeere delivered by Copernicus by 20 min. 23 seconds 14 thirds.

Delibering the causes of this difference to be this, making these beginning of the yeeres to be in one point of the 10 and 9 spheres and the 9 Sphere (before the yeere end) being removed Easterly from the 10 sphere, the yeere end coming to that point of the 12 Sphere againe, is to proceed from it to that point of the 9 sphere also before the yeere endeth.

Mesline delibereth (the Sunne being in the Apogeeum part) that from middle motion to middle motion, the sun passeth 176 deg. 20 min. of the ecliptick: And the sun being in the Perigeum part, from middle motion to middle motion, passeth 183 deg. 40 minutes of the ecliptick, which maketh a difference of 7 deg. 20 minutes.

But from the points of true motions, the halves are equal, each 180 deg. of the Ecliptick: and the arch of time betweene the middle and middle motion of the Sunne in Apogeeum part, is 182 dayes and 6 houres.

Also the Arch of time betweene the true motion and true motion of the Sun in the Perigeum part, is 179 dayes, which maketh the arch of time betweene the middle & the middle motion of the sunne in Apogeeum; more then in Perigeum, by three dayes and 6 houres.

Also maketh the arch of time, betweene the middle and true motion of the sunne in both the meane motions, to be 4 dayes, and the arch of time different from the true motion, to the true motion of the sunne in Apogeeum, from the same points in his Perigeum to be 7 dayes and 6 houres.

And as for the rest of the Theoricks of the Sunne and Moone

I have delibered sufficient in my delibery before, concerning the tides.

But to conclude, Stadius in his Ephemerides, folio 57, of the Equation of the naturall dayes, delivereth as followeth, concerning the time.

We have computed all the places of all the Planets, and also of the Sunne and Moone in this our Ephemerides, for the naturall dayes (to wit, ) for the space, in the which the whole equator is turned about, and moreover 59 minutes and 8 seconds: but because the apparent, and true day now and then doth exceed this time, and now and then is lesse: to wit,

Partly when the Sunne goeth swifter, or slower, by reason of his Prosthaphericks,

Partly for that equall times of the Equator, in the diurnall coartation, or revolution, doe not answer to equall segments, or parts of the Zodiack, it cometh to passe, that this inequality of time also needeth a prosthaphericks, the which notwithstanding cannot be alwayes equall nor certaine.

For the conversion of the Circle of the Equator, though unto the middle and equall Equinoctium, which is the yeere divided into foure equall parts, is evermore equally constant, yet nevertheless, unto the apparant Equinoctium which are the true equinoctis which the excentrick peelds, is found not equall.

Neither doth the Sunnes Apogee occupy a stable seat, because the Apogee fleeteth in the ecliptick every 13 yeeres 1 degree 27 minutes: moreover the Sunne in his excentricity doth some hurt by his shifting, for the excentricity is more and lesse by a eleven semidiameters of the Earth, as aforesaid, and goeth about with the ecliptick.

Wherefore also no limit can be appointed perpetually to this inequality, but in this our Age all these causes conferred one with another, and added together, doe show that the greatest day and lesse day doe differ one from an other, one houre and 28 minutes, that is to say, 22 times (or Meridians) and 20 minutes of the Equator.

But seeing that this inequality of dayes cannot missever the rest of the motions. therefore it is necessary that we should admit them to be equall, unto the which equall dayes, the Tables

of the motions should be both made and set together, the which course we have taken in this our Ephemerides, and for that cause we have borrowed the Canon of equation of dayes out of Erasmus Rheinholdus which agreeth nearest with our age, vntill the yeere 1600.

Therefore according as you find the number in that cannon to adde or subtract: that is the time that the day is eyther longer or shorter, then the equall day, or the day of the Ephemerides, that is the first equated day, or day equated vpon the difference of 88 minutes, whereas the second equation is of dayes once equated, and now doth equate them vpon the difference of 44 minutes, whose halfe is 22 minutes, the greatest number within the cannon.

Seeing there is a first error concerning the time delibered, euen in the motions of the Heavens, as aforesaid, therefore these running Glasses delibering but a second error: the reason is this: because they cannot be made without their imperfections, had need to be most carefully made, and by the precisest workman: that the time delibered by them, may be but according to the second error, for the delivery of the Longitude, by which running glasses, next hereafter nominated, the longitude is better delibered then by any other Instruments.

A glasse whose sand is mettall and the mettall said by some will not rust, notwithstanding in my opinion, it will rust somewhat, and be sometimes mossier, then at other times, likewise the hole that the sand runneth thorough, will grow wider with the force of the sand, the rather being violated by the surges of the sea: which imperfections considered, the glasse must needs deliver the time, sometime shorter, and sometime longer, according to the weather, therefore a second error: yet this glasse is more tolerable then the rest for this delivery, and is to be used before all other, of which glasses there may be diuers sorts, for the delivery of more and lesse at pleasure.

And because the running glasses with sand is more grosser, and that clockes and watches hath their more imperfections, then the former glasse, I will omit them, and leaue the delivery of the time for this present.

Concerning the Windes according to Experience.

**D**ifferences or diversities of windes, I have sene at sea, in some calme day (in Summer time) among divers Shipping being of one flæte, so that some five of them or moze, have all had contrary windes till the wind was settled.

Likewise in Summer time I have knowne in places of small distance, as at Hambrough the wind at west south west, so much winds, that we have rid with our top-mast downe, and at Lee the very same time, the Ships then bound for Hambrough, had as much wind (by report) at east north east, but both those winds continued not long, and betwene which windes no doubt it was calme for the time.

Also in Winter time, I have sene it often in being at sea, the wind being at South southeast, much wind and upon a sudden the wind hath altered to the north west, or north north west, very much wind, and so alterations of winds I have likewise sene upon other points of the Compasse.

And in sayling toward Head-lands, or in sayling about Head-lands I have found the wind sometime too large unto vs, and other times againe too scant unto vs: Therefore the wind very difficult to delate upon, my farther reason is this, because it is delivered in the Scriptures that the wind bloweth, but from whence it commeth or whether it goeth no man knoweth.

Yet notwithstanding, many times in Summer time, but especially in winter time, when growen stormie windes are settled, we may conjecture that they extend farre, and in my opinion (which opinion I hold for a truth) the wind then bloweth in a great circle, therefore cannot be paralell to any great circle of that nature, my reason is this, because great Circles doth crosse themselves at opposite points, as in the demonstrature of the compasse is delivered.

Therefore this delivery confuteth the flat Cards, my reason is this, because the flat cardes delivereth the windes to blow in paralels, according to the lineament thereof.

Likewise by the Card the wind at East, and a Ship going west, eyther in the latitude 33 degrees. 35 minutes, and latitude 60 degrees, or in the north latitude 40 degr. 15 minut, or in what latitude else soever, it is said to lead in paralell, notwithstanding,



ding, the Card delivereth the going West to make right angles with the Meridians which is very absurd, and that the wind continuing, they shall goe west still afoze the wind.

Concerning the Wind by Spherical working.

The 1 Example.

**P**Resuppose a first place (which I will call our place of departure) in any one degree of Longitude whatsoever, and in the North latitude of 33 degrees, 35 minutes, in which place the east and west of the Compass, according to the demonstration, is a Tangent unto this paralell, and crosseth the equator at opposite points 90 degrees in longitude Eastward and westward, which east and west points in the Equinociall keepe in mind,

I purpose from this first place (as aforesaid) to sayle to a second place according to the way of the west upon the difference, which shall be in Longitude from the first place 90 degrees, which 90 degrees, in these paralells is 75 degrees of a great circle or little more: now in this second place which is at this present my place of being, I find my selfe delated from the paralell according to the difference, where I purpose to deliver the East and west (likewise) according to the demonstration, being also a Tangent unto this paralell, and crosseth the Equator at opposite points according to the former, but 90 degrees different in longitude, which two demonstrated semicircles doe crosse each other in 24 degrees 15 minutes of Latitude, 46 degrees in longitude from the first place, and 44 degrees in longitude from the second place.

Now from my first place of departure, the second place doth beare according to the demonstration of the Compass, west north-west, and 5 degrees northerly, upon which point the two places are distant 73 degrees 15 minutes of a great circle, which is a nearer way then the way upon the West according to the difference as aforesaid, by 1 degree 45 minutes.

And from my second place of being, the first place of departure doth beare according to the demonstration of the Compass East north-east, and 7 degrees northerly, upon which point likewise the two places are distant 73 degrees 15 minutes.

So by this delivery having continued the Ships sayping or course west from the first place of departure to the second place.

I doe conclude that the wind being constant and stable in blowing from the first place to the second place, that at the second place the wind is altered of you two points and 7 degrees to the Southward, as aforesaid, though it were at East in the first place, which deliver in my judgement is the truth.

But if the wind being at the first place, be at East, and in sayling to the second place, be variable and alterable, as the East and West by the demonstration is variable by crossing the equator according to the difference in Longitude, then you shall goe from the first place to the second place West as aforesaid (the wind being at east) right afoze the wind, but this way in my judgement is impossible and not the truth.

A second Example.

Being in 60 degrees North latitude and in one Meridian of longitude, which is my first place, which hath his demonstration of East and West accordingly, being a tangent vnto this paralell, and in crossing the equator at opposite points, after the manner in the first Example, from whence I sayle West accordingly to the difference to 90 degrees in longitude, which 90 degrees in longitude in these paralells is 45 degrees of a great circle, little more, which is my second place: in which second place I finde my selfe there to be delated from the paralell according to the difference, and in which second place likewise I purpose to deliver the east and west according to the former, but 90 degrees different in longitude; and these two demonstrated semicircles, doe crosse each other in 50 degrees of latitude 46 degrees 20 minutes in longitude from the first place, and 43 degrees, 40 minutes in longitude from the second place.

So that from my first place of departure, the second place doth beare (according to the demonstration of the Compass) South-west and by west 5 degrees 20 minutes northerly, upon which point the two places are distant 43 degrees 35 minutes of a great Circle, which is likewise a nearer way then the way of the west according to the difference, as aforesaid, 2 degre, 25 minutes.

And from the second place of being, the first place of departure, doth beare according to the demonstration of the Compass, north-east and by east and 8 deg. 20 minut. northerly, upon which point the two places are also distant 42 deg. 35 minut. of a great circle.

So that by this delivery being at this second place, the wind is altered of me three points, and 8 degrees 20 minutes Southward, though it were at the East in the first place.

The 3 Example.

Being in 80 degrees 15 minutes South latitude and in one meridian of longitude, which is my first place, which hath his demonstration of East and West accordingly, being a tangent unto this parallell, and in crossing the equator at opposite points, after the manner in the first example, from whence I sayle West according to the difference to 90 degr. in longitude, which 90 degrees in longitude in these parallels, is 15 degrees of a great circle, little more which is my second place: in which second place I find my selfe there to be delated from the parallell, according to the difference.

And in which second place, I purpose to deliver also the East and West, according to the demonstration, which likewise crosseth the equator at opposite points, according to the former, but 90 degrees difference in longitude, and these two demonstrated semicircles doe crosse each other in 75 degrees, 45 minu. in latitude, 48 degrees in longitude from the first place, and 41 degrees in longitude from the second place.

So that from my first place of departure, the second place doth beare according to the demonstration of the Compasse north west and by west, and 8 degrees northerly: upon which point the two places are distant 14 degrees of a great circle, which also is an nearer way then by the west as aforesaid by one degree.

And from my second place of being, the first place of departure doth beare according to the demonstration of the Compasse north. East, one degree 20 minutes northerly, upon which point the two places are distant 14 degrees of a great circle.

So that by this delivery being at the second place, the wind is altered of me 4 points and one degree 20 minutes to the northward, though it were at the East in the first place.

A thing worth the Noting.

In all the three examples, as aforesaid this thing worthy the noting might be delivered, yet I will deliver but one of them according to the second example in latitude 60 deg. in which second example I deliver, the intersection or crossing of these two semicircles of east & west according to the demonstration from the first place

place of departure and second place, is in latitude 50 deg, which intersection is from the first place west, & from the second place east.

Yet being in this intersection, the first place beareth from it northeast by east, and 5 degrees, 38 minutes northerly, and distant 27 degrees 32 minutes of this great circle.

And the second place beareth from it northwest & by west, 1 degree 40 minutes northerly, and distant 26 degrees, 20 min. of this great circle according to the demonstration of the compasse: and thus much concerning the wind.

Concerning the way of a Ship or Shipping at Sea.

**F**irst, there is to be understood and likewise to be respected by him that hath the charge (whatsoever in navigation) that there is two lawfull and good navigable courses to be used at the Seas, and no more, eyther of which courses is very artificiall (the keeping of them aright) resteth in the good discretion of the said Master, being likewise artificiall, which of them he will use.

But if the said Master be not artificiall, but a man of great conceit, the manner or way of these courses be too deepe for his understanding, and therefore he not worthy to take charge at all.

My reason is this, because all other courses whatsoever more then these two, are absurd, frivolous and false: the names of which two courses folloiweth,

First the course vpon the great Circle being the neereſt way from place to place.

The first course is to saile vpon a great Circle which is after this manner: being in any one latitude and longitude whatsoever, which is your first place, and doe purpose to saile from thence vpon any Azimuths of demonstration whatsoever, which are great circles, vntill you come to 90 degrees in longitude, which is vnto the Horizon of your first place, in which way you are to respect every day at none your Latitude (if you may) and likewise your time as before, or hereafter shall be delibered. For the delivery of your longitude, you are likewise to respect your Sagments, being of what length soever vpon the Azimuths you saile, how you are, (vpon any distance) to crosse the meridians and parallels: for if you finde your selfe in such a latitude, as you should be in, and not in the right longitude, which the Azimuths you should saile vpon giueth, then are you also wide and to seeke

reformation : also if you finde your selfe in such a longitude and not in the right latitude which your Azimuthes giueth, then are you also wide & to seeke reformation, therefore being a harder way, or course to sayle vpon the great circle ( notwithstanding this way the nearest way, or course from place to place of all other wayes ) requiring alwayes reformation with great Iudgement, I will onely deliver 6 examples from one meridian of longitude and latitude 51 deg. 32 min. vpon the demonstration north-west and by north, continuing it from the first place to the Horizon by Segments of 15 deg. of a great Circle a peece, onely for a tast and your farther knowledge of this way and so will leave it, and hereafter will deliver the remainder of the second course or way, which is more easie, according to the difference, being the onely and naturall way indeed that the Compasse leadeth in.

The 1 Example.

Being in the Latitude and longitude, as aforesaid, 15 degrees of a Great Circle from thence, according to the demonstration of North-west and by north, crosseth the 18 deg. 30 minutes, or meridian in longitude westward from the first, and the paralell of north latitude 62 degrees 50 minutes.

The 2 Example.

Other 15 degrees which maketh 30 deg. from the first according to the demonstration of north-west and by north, toucheth the meridian of 50 deg. in longitude westward from the first, and the paralell of north latitude 69 deg 28 min.

The 3 Example.

Other 15 degrees which maketh 45 deg. from the first according to the demonstration, of North-west and by north, toucheth the Meridian of 92 deg. 50 minutes in longitude westward from the first, and the paralell of North latitude 66 degrees, 45 minutes.

The 4 Example.

Other 15 degrees which maketh 60 degrees from the first, according to the demonstration of North-west and by north, toucheth the Meridian of 118 degrees in Longitude westward from the first, and the paralell of north latitude 57 degrees,

The 5 Example.

Other 15 degrees which maketh 75 degrees from the first,  
accoz:

according to the demonstration of  $\text{P.}$  west and by north, toucheth the Meridian of 130 deg. 32 min. in longitude westward from the first, and the paralell of north latitude 44 degrees 35 minutes.

The 6 Example.

The other 02 last 15 degrees, which maketh 90 degrees from the first, and is the Horizon thereof according to the demonstration of the north west and by north, toucheth the Meridian of 139 degrees 15 minutes in longitude westward from the first, and the paralell of north latitude 31 degrees 10 minutes.

And as for the second course 02 way of the Compass upon the difference which we will rely upon, I have delibered sufficiently thereof, as aforesaid, and for that which is also needfull besides concerning this way upon the difference to be delivered, hereafter in good sort and order followeth

There is to be respected by a Master of a Ship, 02 the man that taketh charge in navigation, the goodnesse of the Compass which he sayleth by, with the nutation thereof in any place if it be needfull, otherwise it will cause the way of a Ship to be in an Azimuth contrary to his expectation, which will cause an error.

And for the understanding of this nutation what it is, in any place may be delivered by a man of good conceit, as followeth, having a Topographicall Instrument, 02 otherwise called a Theodolite of brasse, perfectly made, and the Needle good, being well touched with an excellent Stone, and handled for the purpose, delivereth the nutation very well: but if the sea-gate be so great that this Instrument cannot deliver it certaine, then will no Instrument (set forth for this purpose) deliver it neither, then must you worke thus, the height of the Sunne in the Meridian at  $\text{P.}$  one observed by the Compass, the Compass it selfe, then delivereth the nutation from  $\text{P.}$  one, but rather thus: the latitude at  $\text{P.}$  one knowne, then upon any observation of the Sunne by the Compass on any elevation about 3. a clock in the afternoon, the declination respected, the Compass delivereth the nutation more truer, my reason is this: because the descention of the Sunne in his diurnall Arch at this time in the afternoon is more swifter towards the Horizon, then it is, the Sunne being nere the Meridian.

Also that the said Master have with him of the best running Glasses that can be made, as aforesaid, to deliver the time unto him,



as certaine as may be, which must be regarded as a principall thing, the coarting of the Meridians respected, for the delivery of the Longitude in any place, by which way the longitude is delivered after the best manner, the latitude being knowne, otherwise, the time not respected or regarded, the longitude will be delivered with the more error.

Likewise the Azimuth of the way must be delivered or set downe according to the difference, and not otherwise, and not above 20 leagues the Sagment : for the shorter the Sagments be the truer the reckoning, which Azimuths of way vpon the difference, delivereth the longitude also in reasonable sort the latitude being knowne, yet in this way is more absurditie, then in the former way for the delivery of the longitude.

Moreover there is to be respected by him that hath the charge in navigation, the violence of winds, Sea-gates, Tide-gates, Currents, Edies or whatsoever else, that may eyther be helping of the Ship in her way, or a hinderance of her way, which causeth an Azimuth of way, contrary to expectation, which not regarded, bringeth also an error.

And for the obserbing of Latitudes at the Seas, it had need to be very precisely done, having a large Quadrant of brasse with a moveable perpendicular accordingly, delivereth it in the best sort : for in obserbing with Crooke-staves there is error, my reason is this, the staffe not lawfully projected to the great circle, delivereth error : my further reason also is this in obserbing with the staffe, the eye is faine to behold and note two things at once, which is the center of the Sunne, and the Horizon, which is not possible to be done truly.

And in a Sea-gate it can neither be precisely delivered by an Astrolabe, therefore the Quadrant best for this purpose; for in obserbing therewith, there is but onely the center of the Sun, to be respected. Also there must be great care had by him that hath the charge in navigation, vnto the Steeridge of the Ship, that it be greatly respected of him, and of those principall men which goeth in the Ship with him, which he doth appoint for this purpose, because the man at the Steeridge may be negligent, and by some men that may be at the Steeridge, as I have seene my selfe ere now, a 3 or 4 points of eyther side of the course, commanded to be kept.



breaketh no square with him, which had or contrary steridge to expectation, not counted of or noted, causeth a soule error.

And whereas there are infinite sorts of Shipping, for bignesse, length, and drafft, so they are as different in qualities, wherefore I will deliver as many qualities concerning all sorts of Shipping, as at this present I can remember, leading the consideration of the rest, (not now remembred of me, vnto him that hath the charge for the present) with those nominated, according as he shall finde the Ships quality to be which he goeth in, the qualities as followeth.

Of Shipping there are diuers sorts which have diuers qualities the reason is this, because they are different in bignesse and mould, and may be miscrib'd. To proceed, some of them are long, and some short, some of them stottle, and other some of great charge, or drafft, some have a desire or cast to Portward, and some other to Starbord, some of them good to sayle (try) weather about without sayles or hull, rather some qualited to the contrary, some are desirous to have there staves and shrouds slack'd, and some to have them set tought, some Ships desire to be trimm'd a head, some a Kerne, and some others of an even keele, some stereth hard every way, and other some easie of steridge any way: some Ships being in a sea-gate will stay, or wend to windward, and other some cannot, but must wend afoze the wind, which is a great losse of way, long and short Shipping being stotty, are laborious in a sea-gate, but long or short being deepe Shipping, is easie at Sea, some are fast Ships vpon a wind, and some others are leeward, some are good Ships of a sayle quarter winds, and some not so good: some are good afoze the wind, and some others to the contrary, some Ships are stiffe sided which is a principall quality, and some other are tender sided, which is a bad quality, some Ships are of advantage most wayes, and other some are to the contrary.

Therefore the quality of a Ship is greatly to be regarded of him that hath the charge, for a Ship of advantage or disadvantage, causeth an Azimuth of way contrary to expectation, which not being respected causeth an error.

Now for your diurnall by some called a Traversers booke, or booke wherein you keepe reckoning of the Ships way at the Seas, in  
my

my conceit, and as I doe use, is in manner as followeth.

In the head or beginning of which Booke, set downe the Title thereof, with the Moneth, day, and date of our Lord, at the time of your beginning to enter into your navigation: after which being set downe, divide the leafe and so the rest of the leaves up & down into 10 spaces or columes, and set downe in every colume as followeth.

**I**n the first colume of which Booke, set downe the Months and Dayes, according to the sequell of them as the time spendeth.

In the second colume, set downe the Houres of time spent in sayling upon the Azimuths used.

In the third colume, set downe the Azimuth of the wind, or that wind so; the time it was in.

In the 4 colume, set downe the Course which you have kept, that is the course on the true Azimuth, according to the difference.

In the 5 colume, set downe the quantity of Leagues runne upon the Azimuth as aforesaid.

In the 6 colume, set downe the degrees of the Pole elevated.

In the 7 col. also the min. if there be any, of the Pole elevated.

In the 8 colume, set downe the degrees of Longitude delivered by the time and Latitude as aforesaid.

In the 9 colume, also the minutes (if there be any) of the Longitude so delivered.

In the 10 colume, set downe your Discourse of things, according as you find occasion.

And to Conclude.

Every of which inconveniences, or rather good knowledge and understanding as aforesaid, being thus noted, knowne and regarded by him that hath the charge, he shall deliver in his Navigations the Ships way he goeth in with all advantages, who is worthy to be trusted with any charge, and to receive great commendations.

But to the contrary, he that hath the charge, not respecting these things, as aforesaid, he delivereth the Ships way with all absurdities and error, and to speake the truth, he is not worthy to take charge at all, but to have an inferiour place, which he is more fitter for: and thus will I leave delating of the way of Shipping at Sea.



# A N A P P E N D I X.

OR

A necessary Discourse (concerning the Helisphericall lyne that a Ship describeth upon the Superficies of the Sea, being directed by the *Magneticall Needle or Compass.*) Betweene

Mr. *Geograph*, and Mr. *Nautae*  
Enterloquirors.

*Nautae.*



Well met, Mr. *Geograph*?  
*Geograph.*

Mr. *Nautae* and so are you also well met. I have much desired a long while to have some discourse with you.

*Nau.* With me Sir, about what I pray you?

*Geo.* About that which I suppose you are well sene in, I means the way of a Ship upon the Superficies of the Sea, being guided by the *Magneticall Needle or Compass*?

*Nautae.*

Sir, I am very willing to entertaine your motion, and at this present to discourse with you, there are diversities of opinions, concerning the way, motion or moving of a Ship upon the Superficies of the Sea, which way, motion, or moving of a Ship is two-fold, principally in Sayling. That is first spirall, alias Helisphericall, or else secondly it is vnder a great Circle, the spirall or Helisphericall way is produced by the Ships continuall keeping of one course, the foure Cardinall points excepted.

But in the way of sayling vnder a great Circle, the course is alwayes alterable.

And

And whereas the most part of Sea-men will thinks that the demonstration which is delivered by the common plaine Sea-chart (because it is easiest done) is of all other the most exquisite for the truth thereof; Yet is the same indeed, filld with many grosse errors, so that such men must and are often times of necessity greatly deceived of their expectations.

Wherefore for the better understanding of those that are Practitioners in the Art of Navigation, we will in this discourse make relation both of the spirall way of a Ship, in keeping alwayes one course, with the Solution of such doubts, and answering such allegations and objections as may arise thorough want of judgement therein; as also of sayling under a great Circle with the various and changeable position thereof; let me therefore heare your opinion concerning the Rudiments and grounds thereof.

#### Geograph.

First, it is necessary for all Practitioners of Navigation to know, that the Earth and Water together doe make a round or Sphericall body being enclosed with one convexity or superficies, and that the earth and the waters are not plaine or flat soymed, but like unto a round Sphaere or Globe, it may thereby easily be understood, that the courses extended from place to place, cannot be truly described with right lynes, especially in a large distance, because they are Segments of great Circles and are circularly extended, from one place to another.

Hence it followes, that the superficies of the Sea being Sphericall not plaine or flat soymed, that a Ship departing from any assigned place betwene the Equator and either of the Poles, by any one Rhombe or point of the Marriners COMPASSE, the Meridian onely excepted, I say that in keeping one and the same course she maketh her way neither in straight lynes, great Circles or lesser Circles, but in a spirall lynes composed of Segments of great Circles, and returning by the opposite of that Rhombe or point towards the place of her departure, she shall make her way in another spirall lynes, by reason whereof she cannot according to that course fall with the place of her departure.

#### Nautae.

That the course or way of a Ship is spirall yet concentrick to the center of the Earth, and therefore in Segments of great

great Circles, when it is continued by any one Rhome or point of the Compasse (the East and West, North and South, onely excepted, and that when the Compasse hath no Variation) is undoubtedly true.

But whereas you say, that in returning to the place of her departure by the opposite point or Rhome she sayled out, she shall not fall with the place of her departure, (no current nor any such thing to hinder her) you erre very much, yet I would willingly heare by what reason you can prove your opinion.

Geograph.

If you will grant that a Ship maketh her way in Segments of great Circles, then know hereby that all great circles doe in every severall Latitude make severall Angles with the Meridian, also those circles that doe in severall Latitudes make like Angles with the Meridian, have their severall declinations or greatest distance from the Equator.

And by reason of these varieties both in Angles and declinations, or greatest distances from the Equinoctiall, there must also be a variety in the courses made by opposite Angles, and yet both spirall.

For being under the Equinoctiall, an Azimuth of Northeast toucheth the Horizon in Latitude 45 deg. 0 min. North Latitude, 90 deg. distant from the place of being under the Equinoctiall; When comming to the second place in Latitude 45 deg. 0 min. North Latitude, and intending to returne to the first place under the Equinoctiall by the opposite point of Northeast, which is Southwest 45 deg. 0 min. from the Meridian, that great circle or Azimuth intersecteth or cutteth the Equator at more 54 deg. 45 min. which distance is lesse (to returne to the Equator by the opposite point) by 35 deg. 15 min. and is short of the place of departure; also being under the Equinoctiall the Northeast, Southeast, and Southwest Azimuths doe require 1 deg. 24 min. 51 seconds 34 thirds to raise one degree of Latitude.

But being in a paralell 60 deg. 0 min. North, the Northeast and Northwest require 1 deg. 26 min. 13 seconds 3 thirds of distance to raise one degree of Latitude.

And in the same paralell of 60 deg. 0 min. the Southeast and Southwest, require no more but 1 deg. 23 min. 32 seconds 53 thirds,

thirds, for one degree of the Poles depression. Whereby it appeareth that the Segments of North-east and North-west, are greater to raise one degree, then the Segments of South-east and South-west to deprime one degree, by 0 deg. 35 seconds 10 thirds.

Moreover the greater Segments which doe raise the Pole one degree in that Latitude, exceed those under the Equinotiall by 0 deg. 1 min. 21 seconds 39 thirds, and the lesser Segments which deprime the Pole, are lesse then those of the Equinotiall by 0 deg. 1 min. 13 seconds 3 thirds, which might serue for sufficient satisfaction that the way outward and homeward are not alike, againe for your better understanding, you may note, that being at the Equinotiall, a Segment of a great circle of 20 leagues, which maketh with the Meridian an Angle of 45 deg. 0 min. doth raise the Pole and differ the Longitude nere 0 deg. 42 min. 25 seconds 3 thirds.

And in paralell 60 deg. 0 min. North Latitude, a Segment of 20 leagues Southeast or Southwest deprime the Pole 0 deg. 42 min. 58 seconds 8 thirds, and differs the Longitude nere 1 deg. 23 min. 4 seconds 6 thirds, and in the same paralell of 60 deg. 0 min. the like segment of 20 leagues distance Northeast or Northwest eleuate the Pole 0 deg. 41 min. 57 seconds 40 thirds, whereby it plainly appeares, that if the way of a Ship be composed of Segments of great Circles, the way outward and homeward being made by opposite Angles are not alike, yet both Spirall.

Therefore a Ship making her way by any one Rhome or point the Meridian onely excepted, and returning by the opposite point thereof, cannot by course fall with the place of her departure.

And further it must be considered that the greater Latitude is, and the greater the Angle of the course is in respect of the Meridian, the greater is the variety, and the East and West are most variable, moreover in North Latitude, if the course be betwene the South and the East or West, then the way homeward returning by the opposite to the Meridian of the place of departure shall be shorter then the way outwards, and falleth into a lesser Latitude according to the course, distance, and declination from the Equinotiall, but if the course be betwene the North and the East, and the North and the West, then in returning by the opposite, to the Meridian of the place of departure, the way homeward

wards shall be longer then the way outwards, falling likewise in to a lesser Latitude, according to the course, distance, and the declination from the Equinoctiall.

Nautae.

If the Spirall or Helisphericall way of a Ship upon the Superficies of the Sea, being composed of Segments of great Circles, had also those Segments limited or bounded to containe 20 or 30 leagues a pece, then should all your former allegations be true, but those Segments in regard of their smallness cannot be sensibly distinguished, neither can it be certainly said, that a Ship in keeping alwayes one course, continueth vnder one great circle 1 league or 1 mile; for when the course is alwayes continued according to any one point of the Compass, it maketh an oblique Angle with the Meridian, and then so often as the Ship changeth her Zenith, so often she changeth likewise the great Circle. She maketh her way in, that is to say, so many Zeniths as she passeth vnder, so many great Circles she maketh her way in, and each of those Circles make severall Angles with the Equinoctiall, and the greater the Latitudes are the greater are the Angles, for in the Latitude of 59 deg. 30 min. the verticall circle of Southwest and Northeast maketh an Angle of 68 deg. 58 min. with the Equator, and in Latitude 60 deg 0 min. the Azimuth of Southwest and Northeast maketh an Angle of 69 deg. 18 min. with the Equinoctiall. Also in paralell 60 deg. 30 min. the Southwest and Northeast Azimuthes make an Angle of 69 deg. 37 min. with the Equator, and in the Latitude of 68 deg. 58 min. it makes an Angle of 69 deg. 18 min. and in the Latitude of 69 deg 37 min. the foresaid great circles make right Angles with the Meridian, and are circles of West and East, yet notwithstanding the variable Angles that these great circles make with the Equinoctiall, and the contrary Angles, that every great circle maketh with every new Meridian, I say that in regard those Segments that a Ship maketh her way in are so small and insensible. She shall in keeping one course outwards, produce a spirall or Helisphericall line, and returning by the opposite point thereof she shall againe passe vnder all those Zenithes, that she did in her way outward, and in like Segments, and shall by the same line of inclination, fall again with the place of her departure.



But when a Ship maketh an East or West way the lynes of her Caping maketh alwayes right Angles with the Meridian, then shall those great Circles of whose Segments the Ships way is composed make like Angles with the Equator, that is to say equall to the Latitude, and the Ship shall according to that course runne a paralell to the Equinoctiall.

Geograph.

One thinks that is strange that you will allow the East and West way of a Ship being made in Segments of great Circles to enter the Equator at East and West, by reason whereof they are Touch-lines to the paralell of Latitude, and yet you will not allow or grant the East and West to make a spirall way as well as the rest.

For how is it possible that the lynes of Inclination or way of a Ship being composed of Segments of great Circles, and those Touch-lines to the paralell of Latitude, so that the Ships Caping is quite contrary to the paralell and maketh oblique Angles therewith, and that especially in great Latitudes, how then is it possible that the East and West should lead in a paralell or produce a lesser Circle or any part thereof.

Nautae.

Take a small Compasse syle, and fasten it to a threed that may passe thorow the North and South points thereof, and make a nole in the end of the threed and put it upon the Axis of the Globe at the Pole, then carrying the syle with the threed about the body of the Globe, and you shall see the center of the syle describeth a paralell to the Equinoctiall, and yet the East and West of the syle alwayes respecteth the Equinoctiall at 90 degrees 0 minut. of distance.

And so would a Ship if shee had a hater or some thing else fast about the Pole to attract her thereunto.

Geograph.

But by the Globe thus doe fasten the quadrant of Altitude to the Equinoctiall in the brasse Meridian, and bring the beginning of the degrees of the quadrant to paralell 60 deg. 0 min. and then from that point where the beginning of the degrees of the quadrant do touch in paralell 60 deg. 0 min. along by the edge of the quadrant to the Equinoctiall is the lynes of East and West.

nole

note with the point of an needle or some such thing pick of by the edge of the quadrant 1 deg. 0 min. and make a marke there, then move the Globe untill the beginning of the degrees of the quadrant doe sit with that marke, and then as before pick of againe 1 deg. 0 min. by the edge of the quadrant, and so proceed by 1 deg. 0 min. untill you have gone round about the Globe, and that the point of the Needle fall in the first Meridian where you began, and you shall find the lynes of the Inclination to be dilated from Latitude 60 deg. 0 min. about 1 deg. 30 min. and so further prove hereof suppose your selfe to be vnder the Equinoctiall, and the Compass to have no variation, and the Ship to cape East or West, also the maine-mast to stand by right in the Keppe, the head thereof pointing to the Zenith, and the heele to the Radir or rather to the center of the earth, and the mid-Ship beame making right Angles with the mast to be paralell to the Axis of the world, I say, that this Ship proceeding East or West in this manner maketh her way in a great Circle to wit in the Equinoctiall, and returning by the opposite point thereof shall againe fall with the place of her departure.

Now I say by the same reason, that if the said Ship being in any Latitude betweene the Equator and either of the Poles, in Caping East or West, her mid-Ship beame shall then be a paralell to the plane of the Horizon, and also to the Axis of that great Circle or Circles which in her proceeding lynes of Inclination she maketh her way in; the head of the maine-mast pointing to the Zenith, and the heele to the Radir, and the lynes of her Caping maketh contrary Angles with every new paralell. Now if a Ship in sayling vnder one Circle must have her mid-Ship beame alwayes paralell to the Axis of that great Circle she maketh her way in, then in keeping directly vnder one paralell, her mid-Ship beame must be alwayes paralell to the Axis of the world, so that is the Axis of every paralell, and so likewise the maine-mast being rectified perpendicularly in manner as aforesaid, must be also a paralell to the Equinoctials diameter, and make an Angle with the Horizon equall to the Latitude, the head thereof not respecting the Zenith, nor the heele the Radir nor the Center of the earth, but the Center of the paralell of her Latitude, and in this manner a Ship may runne in a paralell to the Equinoctiall,

But

But how this may stand with humane reason, I leave to your further construction.

Nautae.

Herein you are notably deceived as it shall presently at large be made plaine and evident, for whereas you say that the way of a Ship, cannot describe a paralell to the Equinoctiall except her mid-Ship beame be paralell to the Axis of the world, I say that so long as the mid-Ship-beame remaineth due North and South, that is to say paralell to the Meridian Diameter in the plane of the Horizon, although the head of the maine-Mast (it being perpendicularly erected) point to the Zenith, and the heele to the Nadir, so long I say, her way shall describe a paralell to the Equinoctiall, but as I said before you seeme by all your former allegations to prove, that the way of a Ship, being composed of Segments of great Circles should have those Segments limited or terminated, to containe 15, 20, or 30 leagues a peece, which if it were so, then should it be altogether according to your saying.

But now for as much as there is some difficulty in the premises and few Mariners know how to censure thereof, I will therefore briefly prove by Arithmeticall calculation, the East and West in any Latitude to lead in a paralell as well as the Equinoctiall.

Example.

The paralell of 60 deg. 0 min. is equall to the length of halfe the Equinoctiall or 180 deg. 0 min. of a great Circle; we will therefore in the same make our beginning and from the first place being situate therein, produce 18 Segments which containe 10 deg. 0 min. a peece, which by Arithmeticall calculation may be thus found out.

The Theorem. viz.

**A**s the Radius is to the sine of the Latitude 60 deg 0 min. so is the sine of the Complement of the distance the sine of 80 deg. 0 min. to the sine of the Latitude of that place where the first Segment of 10 deg. 0 min. endeth, and so againe in like manner for the second Segment.

viz. As the Radius is to the sine of the Latitude where the first Segment endeth, so is the sine of the Complement of 10 deg. 0 min. to the sine of the Latitude where the second Segment endeth,

deeth, and this is to be continued 18 times, so shall you find the last worke to bring forth the line of 41 deg. 06 min. but if you worke by Logarithme lines, multiply the Logarithme line of 80 deg. 0 min. (the Complement of 10 deg. 0 min.) by 18, because there are 18 Segments, and the product adde to the Logarithme line of 60 deg. 0 min. the Latitude given, the summe will be the Logarithme line of 41 deg. 06 min. the Latitude of the 18 Segment, which dilateth from Latitude 60 deg. 0 min. the sum of 19 deg. 0 min. wanting but 8 deg. 06 min.

From whence we may see, that if great Segments haue such great alterations, then lesser Segments must haue their correspondent varieties proportionall vnto them, but marke what follows, and I make no doubt but that anon you will be of another opinion then formerly you haue bin concerning this matter, as from the aforesaid paralel 60 deg. 0 min. let there be produced 36 Segments according as was afore shewed, each Segment containing 5 deg. 0 min. or 100 leagues a peece, and you shall find the end of the last Segment to fall in Latitude 49 deg. 41 min. which is dilated from paralell 60 deg. 0 min. but 10 deg. 59 min. where note that this dilatation is lesse then the former by 7 deg. 55 min.

In like manner, in the same paralell 60 deg. 0 min. let there be produced 180 Segments of 1 deg. 0 min. or 20 leagues a peece, and you shall find the end of the last Segment to fall in Latitude 57 deg. 25 min. which is dilated but 2 deg. 35 min. from paralell 60 deg. 0 min.

Againe, let 10800 Segments be produced in the same paralell of 60 deg. 0 min. of 0 deg. 1 min. one minute a peece due East or West and working according to the former manner, the last Segment will end in 59 deg. 57 min.  $\frac{1}{2}$ , which dilateth from paralell 60 deg. 0 min. but  $2\frac{1}{2}$  minutes, wherefore the consideration hereof may serue for a sufficient satisfaction plainly to proue that the East and West directed by the magneticall Needle or Compass doth lead in a Magneticall paralell, for as great Segments haue their great varieties, and lesser Segments haue their lesser alterations correspondent vnto them so by the same reason insensible Segments must haue insensible differences, and the like reason holdeth for any other point of the Compass, as well as for the East or West as I haue formerly shewed you, and at our next

meeting I will let you knowe of How you the Theorems for operating of it.

But you will say, here is in 10800 minutes a difference of 2 $\frac{1}{2}$  minutes, and Segments of minutes in a mans judgement are so small that a Ship cannot make her way in lesser Segments and yet these Segments are not void of a sensible difference, I answer as before, that neither in sayling East or West, nor in the spirall or Helisphericall way by any other course or point of the Compass, a Ships continuance vnder a great Circle or Circles cannot be terminated, and whereas 10800 minutes doe in the East or West from Latitude 60 deg. 0 min. produce a difference of 2 $\frac{1}{2}$  minutes, I say in respect of so great a distance, the difference is insensible.

But if you please to take so much paines for the former parallel of 60 deg. 0 min. to make a tryall from second to second, that is but 64800 Segments be produced East or West each Segment to containe one second and the end of the last Segment shall not be from the first place, so much as one second, and thus having proved sufficiently that the East and West being directed by the magneticall Needle or Compass, both lead in a magneticall parallel, and also that in keeping one course the Ships way is spirall or Helisphericall, and returning by the opposite point thereof, the Ship shall againe fall with the place of her departure, I will finish this discourse, and speake of some principall rules which of all sea-men and Marriners ought to be knowne.

#### Geograph.

What is the first and most usefull Proposition in the Marriners practise to be taken notice of.

Nau. By the course and both Latitudes to find the difference of Longitude and the distance.

Geo. For what reason is that proposition in sayling the primary and most usefull.

Nau. Because the course is commonly given, and the Latitudes may be knowne by observation, but the distance and the difference of Longitude by sayling may be supposed but not certainly knowne without the helpe of the former, and so likewise the distance in sayling East or West may be supposed, but not certainly knowne.

## The Path-way to perfect Sayling.

5

Geo. I pray you Sir, let vs then proceed, to the practise without any further circumstance, that having both Latitudes and the course we may finde the difference of Longitude and the distance.   
 Nau. We will Sir.

Suppose a ship to be in Latitude 50 deg. 0 min. South Latitude sayles South South-west; point West, untill she be in the Latitude of 47 deg. 0 min. I demand the difference of Longitude and the distance the ship hath runne.

The Theorem.

**A**s a meane proportionall betwene the sines of the Complements of both Latitudes is to the Tangent of the course, so is the difference of Latitude to the difference of Longitude, which by the Logarithmes is thus.

Adde the Logarithme tangent of the course 25 deg. 7 min. to the Logarithme of the difference of Latitude 60 leagues, and from that summe subtract halfe the sine Complement of 50 deg. 0 min. which is halfe the sine of 40 deg. 0 min. and halfe the sine Complement of 47 deg. 0 min. which is halfe the sine of 43 deg. 0 min. added together, (I means Logarithme sines) and the remainder shall be the Logarithme of the difference of Longitude.

Geo. What is the second most usefull proposition that a Marriner in his practise is to take notice of.

Nau. By both Latitudes and the departure from the Meridian to find the difference of Longitude the course and the distance.

Geo. Wherefore doe you account this to be the second most usefull proposition in the Marriners practise.

Nau. Because all Marriners that keepe their account by difference of Latitude and difference of Longitude (which onely is the true way) after that they have run by their Traverses by difference of Latitude and departure from the Meridian, doe find their difference of Longitude as well as their course and their distance from their first place, where they began their Traverses this way.

Geo. I pray you Sir, let me downe the Theorems for the operating of this.

Nau. I will Sir, which are these following.

1 As the summe of halfe the Logarithme sines of the Complements of both Latitudes is to the departure from the Meridian, so is the Radius to the difference of Longitude.



2 As the difference of Latitude is to the departure from the Meridian, so is the Radius to the Tangent of the course.

3 As the sine of the Complement of the course is to the Radius, so is the difference of Latitude to the distance that the Ship hath runne from the first place where she began her Traverse.

Geo. What is the third, and as I remember you said the last usefull proposition to be taken notice of in the Mariners practice.

Nau. By having given the Latitudes of two places and their difference of Longitude to find the magneticall course or Rhomb, and the distance.

Geo. How can this be usefull for a Mariner in his practice.

Nau. Because many times it chanceth that a Mariner is to saile from one port whose Latitude and Longitude he hath in Geographickall tables (as in Mr. Hughes his use of the Globes or in the Tables of the Sea-mans Kalender) and is to saile to another port, whose Latitude and Longitude he hath also in the said Tables, and by this proposition he may examine the truth of his Sea-chart he sailes by.

Geo. Set me downe the Theorems for this proposition, and I will trouble you no further at this time.

Nau. Sir, I am in some haste because the time is farther spent then I supposed since we met, but I will performe your request, and then I will take my leave of you for this time.

First, as the difference of Latitude is to the difference of Longitude, so is halfe the sines Complements of both Latitudes (I mean of the Logarithmicke sines) to the Tangent of the course.

Secondly as before, as the sine Complement of the course is to Radius, so is the difference of Latitude to the distance runne.

Geo. Master Nautae, I thanke you very kindly for your company, and your conference, you have informed my judgment very much in the matter of Navigation.

Nau. Sir, I am very joyfull of it, fare you well.

FINIS.



S

N

Ho

Ma

E

Printe